ATTACHMENT D
SCOPE OF WORK (BOP)

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ATTACHMENT D
SCOPE OF WORK (BOP)

1.0 ATTACHMENT INFORMATION

1.1 Purpose

1.1.1 **Without limiting the information summarized herein, the purpose of this document is (a) to summarize the minimum scope of work requirements for Contractor, which generally include the engineering, procurement, and construction of the balance-of-plant infrastructure for the Project, as well as the installation and all tasks necessary to achieve Wind Turbine Mechanical Completion of all Wind Turbines; and (b) to summarize the minimum performance specifications, quality standards, and other criteria required for the engineering, procurement, and construction of the Project.**

1.2 Project Description

1.2.1 **The [Project Name] Wind Project is a nominal up to 400 megawatt wind energy project using a quantity of [quantity] [model] Wind Turbines located in [County Name] County, [State Name]. [RFP Clarification: Highlighted Project details to be filled in by Bidder. Applies throughout.]**

1.3 References

1.3.1 **In addition to anything summarized herein, all Work related to the Project shall conform to the following Owner standards:**

(1) Exhibit 6 – MP Site Construction Specification – Fence

(2) Exhibit 7 – MP Electrical Construction Specification - 35kV Collector System

(3) Exhibit 8 – MP Substation Specifications

(4) Exhibit 9 – MP Control Standards and Specifications

1.4 Definitions

1.4.1 **For purposes of only this exhibit, the following words shall have the respective meanings set forth below.**

(1) "**Applicable Permits**" means all permits required for the siting, construction, and operation of the Project.

(2) "**Applicable Standards**" means the minimum standards and industry codes and any other criteria required for the performance of the Work by Contractor, including those set forth in Exhibit 3 (*Applicable Standards*).

(3) "**As-Built Drawings**" means a complete set of drawings prepared by Contractor or a Subcontractor which accurately and completely represent the Work as constructed and installed.

(4) "**Collection System Circuit**" means the permanent electrical and communications infrastructure required to transmit energy and performance and operating data between each Wind Turbine and the Project Substation, or to the Turbine SCADA System control panel as appropriate.

(5) "**Contractor**" means the person, firm, or corporation with whom Owner has entered into the Agreement.

(6) "**Contract Price**" means an amount equal to [$TBD] to be paid to Contractor by Owner as full and complete payment for all Work to be performed by Contractor under the Agreement.

(7) "**Interconnection Line**" means the [VOLTAGE]-kV high-voltage transmission line connecting the Project Substation with the Point of Interconnection.

(8) "**Job Book**" means a manual to be prepared by Contractor and approved by Owner, which will include all Contractor engineering, design, purchasing, and other information relating to the Work.

(9) "**NTC**" means Notice to Contractor

(10) "**O&M Building**" means the operations and maintenance building for the Project.

(11) "**Owner-Supplied Equipment**" means [TBD].

(12) "**Project Site**" or "Site" means the location, or proposed location, of the Project.

(13) “**Project Substation**” means the 34.5/[VOLTAGE]-kV substation to be located at the Project Site, with all necessary equipment to connect the Project to the interconnecting utility’s grid.

(14) “**Prudent Wind Industry Practices**” means (a) those practices, methods, equipment, specifications and standards of safety, performance, dependability, efficiency and economy as are acceptable for construction and professional engineering firms performing desi engineering, procurement and construction services in North America on facilities of the type and size similar to the Project, which in the exercise of reasonable judgment and in the light of the facts known at the time the decision was made, are considered good, safe and prudent practice in connection with the design, construction and use of electrical and other equipment, facilities and improvements, with commensurate standards of safety, performance, dependability, efficiency and economy, are in accordance with generally accepted national standards of professional care, skill, diligence and competence applicable to design, engineering, construction and project management practices, and are consistent with Applicable Laws; and (b) those practices, methods, standards and acts that at a particular time in the exercise of reasonable judgment would have been acceptable to those engaged in, or approved by a significant portion of, the wind power industry for similar facilities in similar geographic areas as a reasonable effort to accomplish the desired result in a manner consistent with Applicable Laws, Applicable Standards, safety, environmental protection, economy and expedition.

(15) “**RFP**” means request for proposals.

(16) “**Turbine SCADA System**” means the Supervisory Control and Data Acquisition system, including all monitoring/control hardware and software, field instrumentation and communication devices.

(17) “**Turbine Foundation**” the supporting structure for each wind turbine generator.

(18) “**Turbine Supplier**” means the Original Equipment Manufacturer of the wind turbine components.

(19) “**Wind Turbine**” means each of the complete, fully-functional wind turbine generators to be part of the Project.

(20) “**Point of Interconnection**” means the Point of Interconnection which defines the location of the physical electrical interconnection to the Transmission Provider as defined in the Interconnection Agreement.

(21) “**Submittal Schedule**” means the schedule for Contractor’s delivery of submittals, as set forth in Exhibit 1 (*Submittal Requirements*).

(22) "**Communications System**" means the supervisory, control, and data acquisition system for the Project Substation equipment (including all breakers, switches, transformers, relays, and meters) and permanent meteorological towers, as well as all fiber optic cabling and supporting devices within the Collection System Circuits.

(23) "**Equipment**" means all of the parts, components, equipment, materials, apparatus, structures, tools, supplies, consumables, goods, and other items required or appropriate for a complete, fully-functional Project or that otherwise form or are intended to form part of the Work or the Project, *including* all equipment, materials, apparatus, structures, tools, supplies and other goods provided and used by Contractor and the Subcontractors for performance of the Work, but that are not incorporated into the Project, and *excluding* all Owner-Supplied Equipment.

(24) "**Raceway**" means all conduit (rigid and flexible), underground duct, wireway, cabinets and boxes, and all materials and devices required to install, support, secure, and provide a complete system for support and protection of electrical conductors.

(25) "**Requirements**" means the Specifications in Attachment D, Prudent Wind Industry Practices, Applicable Law, Applicable Permits, Applicable Standards, the Project Schedule, the Interconnection Agreement, the designs in Exhibit [●] (*Preliminary Design Exhibit Name*), the landowner requirements in Exhibit [●] (*Landowner Agreement Exhibit Name*), the Utility Specifications, the Turbine Supplier Project Site Requirements, the Owner standards, and the other requirements of the Agreement. **[RFP Clarification: Exhibit names to be discussed and finalized during Agreement negotiations. Applies throughout for highlighted items.]**

(26) "**Roads**" and "**roadways**" means all access roads, Wind Turbine string and spur roads, substation roads, transmission line service roads, meteorological tower roads, operations and maintenance building roads, and temporary construction roads to be constructed for the Project by Contractor.

(27) "**Wind Turbine Pads**" means both crane pads and hardstands, where (a) "**crane pads**" refer to a hardstand area in connection with the erection or service of a Wind Turbine and (b) "**hardstands**" refer to any area where Wind Turbine components, Wind Turbine equipment, transport equipment, or storage equipment are stored, placed, or parked, and including parking areas, laydown areas, and other such working areas.

1.5 Interpretation

1.5.1 **References herein to requirements to perform and/or provide work, services, equipment, or other similar items shall be understood to be the responsibility of Contractor, unless explicitly noted as being a responsibility of Owner.**

1.5.2 **Unless expressly noted otherwise, any requirement to "provide", "supply", or "furnish" goods or services herein shall be considered equivalent.**

1.5.3 **The headings of sections and subsections herein are for convenience only and shall be ignored in construing this exhibit.**

2.0 GENERAL SERVICES

2.1 General Provisions

2.1.1 **Contractor shall perform and/or provide all work, design services, procurement services, construction services, permitting services, supervision, management, labor, equipment, materials, parts, apparatus, tools, consumables, temporary structures, temporary utilities, storage, quality control and other items necessary or appropriate to complete the Work described herein, unless explicitly stated otherwise, and all such Work shall be included in the Contract Price.**

2.1.2 **Contractor shall perform all Work in conformance with the Requirements. In the event of any conflict or discrepancy between this exhibit and any Requirement, the more stringent or higher quality Requirement shall take precedence over the less stringent or lesser quality Requirement. In the event that the conflict or discrepancy between this exhibit and the Requirements is part of Owner's Specifications, Contractor shall confirm with Owner for preferred design requirement.**

2.1.3 **Contractor's proposal shall include recommended list of spare parts for both the wind turbines and balance of plant facilities. Such list shall include recommended quantities, part/model numbers, and nominal pricing.**

2.1.4 **Contractor shall provide supervision, inspection, testing, and quality control of the Work to ensure it is completed safely, competently, and efficiently. Contractor shall devote attention, skills, and expertise as is necessary to perform the Work in accordance with the Requirements. All materials shall be new, unused, of the highest quality, free of defects and irregularities, and consistent for use in wind generation facilities. Equipment shall be installed, assembled, and tested in strict compliance with the manufacturer's drawings, manuals, code markings, and instructions, and any proposed materials, structures, and/or assemblies shall be maintainable in the simplest and most cost-effective manner possible.**

2.1.5 **All Work, including construction, materials storage, grading, landscaping, cut/fill, erosion control, and other similar or related activities, shall not extend beyond the designated disturbance limits shown on Exhibit [●] (*Project Site Plan Exhibit Name*). Unnecessary disturbance of the existing Project Site conditions shall be minimized, and under no circumstance may Contractor perform any Work or cause any disturbance beyond these corridors without explicit written confirmation from Owner.**

2.1.6 **Contractor shall not construct any portion of the Work until the applicable issued-for-construction drawings have been approved by Owner. Turbine Foundations shall not be constructed until (a) the Turbine Foundation drawings and calculations have been approved by Owner, including its independent engineer; and (b) until pre-determined hold points have been approved by Owner, including inspection of rebar placement prior to pouring concrete.**

2.1.7 **Contractor shall design all aspects of the Project based on verifiable criteria that are specific to the Project and the Project Site, including elevation, terrain, ground cover / vegetation, corrosivity, precipitation (rain, snow, ice), frost depth, seismic loads, and subsurface conditions. All such design criteria shall be clearly displayed on the design drawings.**

2.1.8 **Notwithstanding any reference to specific codes or standards herein, all Work shall comply with the latest revision of the Applicable Standards, including those set forth in Exhibit 3 (*Applicable Standards*) to this exhibit. The method for handling conflicts between Applicable Standards shall be as set forth therein.**

2.1.9 **A list of Approved Suppliers is shown below which contains a list of approved materials and equipment suppliers. If Contractor is considering the selection of a material, equipment supplier, or subcontractor that is not listed herein, Contractor shall request approval from Owner prior to executing any contract for the procurement of such material or with such equipment supplier or subcontractor. Equipment catalog cut sheets shall be submitted for Owner review and approval prior to procurement. Owner reserves the right to request proposed suppliers for other materials and equipment.**

(1) Substation Transformer

(a) Delta Star

(b) HICO

(c) Hitachi

(d) Hyundai

(e) Siemens

(f) OTC-SMIT

(g) WEG

(h) Other supplier as per 2.1.8 requirements.

(2) Medium Voltage Transformer

(a) ABB

(b) CG

(c) Howard

(d) Eaton

(e) WEG

(f) Other supplier as per 2.1.8 requirements.

(3) Transmission Substation Breaker

(a) Hitachi

(b) Mitsubishi

(c) Other supplier as per 2.1.8 requirements.

2.1.10 **Unless explicitly stated otherwise, including for Turbine Foundations as set forth in <u>Section 4.1.3</u> herein, the minimum design working life of the Work shall be 20 years.**

2.1.11 **Requirements for rigging and tooling:**

(1) All rigging shall be rated; inspected daily; and load tested in accordance with the Applicable Standards or other more rigorous requirements set forth in the HSSE Plan. The manufacturer-rated capacities shall be legible and permanently affixed. Inspection reports shall be maintained at the Project Site and available for review by Owner.

(2) Copies of testing certificates and calibration records for all tooling shall be maintained at the Project Site and available for review by Owner.

(3) Contractor shall utilize tooling in accordance with manufacturer recommendations, including any Turbine Supplier guidelines for use of Special Tools.

2.2 Site Conditions

2.2.1 **Contractor shall inspect the Project Site prior to initiating the Work to obtain such additional or supplementary examinations, investigations, explorations, surveys, tests, studies, and/or data concerning conditions at or contiguous to the Project Site or otherwise, which may affect cost, progress, performance, or furnishing of the Work. All such inspections shall have been contemplated and included in the Contract Price, and Contractor shall not be entitled to request or be granted any scope change claims based on the results of these investigations.**

2.2.2 **Contractor shall furnish weather equipment at the Project Site capable of measuring rainfall, wind speed, and other conditions as necessary to determine the occurrence of wind days and abnormally severe weather conditions, respectively.**

2.2.3 **Any existing infrastructure, including communications towers, pipelines, telephone lines, and electrical lines, shall be maintained in their current condition throughout the construction of the Project. Existing access to the Project Site, including along public roads, shall remain open throughout construction.**

2.3 Construction Management

2.3.1 **Contractor shall provide traffic control at and within the Project Site, or as otherwise required to complete the Work, including, but not limited to, traffic control along any public roads.**

2.3.2 **Contractor shall furnish and maintain throughout construction of the Project a construction radio system for use by Owner and Owner's representative(s), including access to Contractor's primary safety channel. At least five (5) fully-functional radios shall be furnished for this purpose. This radio system shall be fully functional within 30 days of Contractor mobilization.**

2.3.3 **Contractor shall provide all necessary construction water, including, but not limited to, that which is required for temporary work, concrete preparation, dust control, rock drilling operations, and pressure washing of Wind Turbine components.**

2.3.4 **Contractor shall provide all necessary temporary/construction power, including, but not limited to, that required for the office trailers, temporary lighting, Project Substation, O&M Building, and meteorological towers. For the avoidance of doubt, Contractor shall be responsible for furnishing both the power supply and fuel source for such items.**

2.3.5 **Contractor shall provide all necessary fire management devices, per the fire management plan to be prepared by Contractor as a Contractor Deliverable, including water trailers, construction vehicle fire kits, or other similar devices, as applicable.**

2.3.6 **Contractor shall attend and actively participate in Owner-scheduled project meetings. These meetings may include, but are not limited to, (a) engineering update meetings to review progress against the Project Schedule, address issues related to the Work, and other similar items prior to construction of the Project; and (b) Project management meetings during construction, including plan of the day, daily safety meetings, daily logistics planning, Project Schedule progress, weekly management updates, and monthly management updates.**

2.3.7 **Contractor shall support Owner with providing timely responses to reasonable requests for information from Owner or Owner's Contractors, including Turbine Supplier.**

2.3.8 **Contractor shall ensure compliance with all landowner agreements as further prescribed in Exhibit [●] (*Landowner Requirements Exhibit Name*).**

2.3.9 **Contractor shall contact local authorities, pipeline companies, and utility companies to locate conflicting underground facilities *prior* to starting any excavation or trenching Work. Contractor shall be responsible for all damages resulting from contact with identified underground facilities in the vicinity of each excavation, including, but not limited to, those identified through the local "One-Call" service, the Owner-provided ALTA survey, or other similar information made available to Contractor or available to Contractor through the exercise of reasonable diligence. In the event of any conflict with an underground facility, Contractor shall immediately notify Owner and shall document the nature of the conflict, relocation of the conflicting facility or structure, any damages which occurred, and final resolution. This documentation shall be provided to Owner within 48 hours of such conflict.**

2.4 Project Documentation

2.4.1 **Contractor shall prepare and submit all deliverables and submittals necessary for the successful completion of the Work, including, but not limited to, Job Books, As-Built Drawings, completion certificates, design documents, and all other manuals, drawings, plans, studies, calculations, safety-related documentation, reports, checklists, completion procedures, and other similar items (collectively, the "Contractor Deliverables"). All Contractor Deliverables shall be coordinated and discussed with all pertinent parties prior to and during the construction phase of the Project; shall be subject to review and/or approval by Owner, as applicable; shall be submitted by the applicable dates in The Submittal Schedule; and shall meet the minimum requirements for submittals set forth in Exhibit 1 (*Submittal Requirements*) to this exhibit. The following list provides an indicative sample of Owner requirements for specific Contractor Deliverables for the sole purpose of ensuring clarity of expectations for the referenced submittals; *this list is not intended to be an exhaustive listing of all Contractor Deliverables or the requirements thereof*.**

(1) Contractor shall prepare, implement, and manage a detailed Project schedule that reflects the Project execution plan and anticipated sequence of site operations (the "**Project Schedule**"), and shall cause the reports summarized in Exhibit 2 (*Schedule Requirements*) to this exhibit to be submitted with each weekly Project Schedule update; the Project Schedule shall comply with the minimum requirements set forth in Exhibit 2 (*Schedule Requirements*) to this exhibit. Contractor shall also provide an individual (the "**Scheduler**") who shall (a) be dedicated to the Project; (b) develop and maintain the Project Schedule; (c) be an experienced specialist that is skilled in critical path method scheduling; (d) be capable of producing CPM reports within 24 hours of Owner's request; and (e) attend (either remotely or in person) and actively participate as needed in all Project meetings related to construction progress, alleged delays, or time impact.

(2) Contractor shall prepare, implement, manage, and observe the health and safety plan, the security plan, and the environmental plan (collectively, the "**HSSE Plan**"). These plans shall conform to the minimum requirements set forth in the Agreement and Exhibit [5] (*MP Contractor Environmental Requirements*).

(3) Contractor shall prepare, implement, and manage a detailed quality assurance plan that is specific to the Project and Project Site. This plan shall conform to the minimum requirements set forth in the Agreement).

(4) Contractor shall provide one (1) complete copy of Job Books in hard copy format *and* one (1) complete copy of Job Books in electronic format on CD, DVD, or flash drive. Job Books shall conform to the minimum requirements set forth in Agreement and Exhibit 4 (*Job Book Requirements*) to this exhibit.

(5) Contractor shall provide one (1) complete, full-size (size D), color set *and* one (1) complete, 11-inch by 17-inch, color set of As-Built Drawings in hard copy format, as well as one (1) complete, full-size (size D) set of As-Built Drawings in electronic format on CD, DVD, or flash drive.

(6) Contractor shall prepare, implement, and manage a detailed project execution plan that is specific to the Project and Project Site. The project execution plan shall be sufficient in scope and detail to convey the means and methods that will be employed by Contractor to perform all aspects of the Work. Key elements of the project execution plan shall include, but not be limited to, project management structure and key personnel; roles and responsibilities; staffing plans; communications protocol; engineering execution plans; security plans, including, but not limited to, guards / patrols, weapons, emergency procedures, and incident notification procedures; and construction management plans, including, but not limited to, cost controls, schedule controls, mobilization, document management, materials management, details for receipt and transport of equipment, traffic management (including concrete trucks), construction sequencing, movement of cranes during construction, and other similar items.

(7) Not used.

(8) Contractor shall prepare, implement, and manage critical lift plans that are specific to the Project and Project Site. The critical lift plan shall clearly identify precautions for all critical lifts; coordination plans, including pre-lift meetings, with all participating personnel; and sample documentation/checklists for all critical lifts. Prior to performing any critical lift, Contractor shall perform a practice lift with a similar crane configuration and load configuration; practice lifts shall always be performed with the same crew and using the same lifting equipment as those used for the critical lift; to the extent that Contractor has successfully performed a practice lift, any subsequent, identical lifts shall not require another practice lift. Any lift exceeding ninety-five percent (95%) of a crane's load chart is prohibited. For purposes of this exhibit, a "critical lift" shall include, at a minimum, any lift that exceeds seventy-five percent (75%) of the rated capacity of the crane, per the respective crane's load chart; any lift that exceeds 50,000 pounds; any lift that requires the use of more than one crane; any lift requiring blind picks; any man-basket lifting operation; any load that is lifted/transported over or near energized electrical equipment, such as power lines, transformers, or switchgear; any lift in a confined space or restricted area (including an operating facility) where the load, or any part of the crane or equipment structure, could come within three (3) feet of any existing structure; or any lift where the equipment is set up near manholes, catch basins, sewers, sinkholes or other known surface or sub-surface interferences.

(9) Contractor shall prepare a spill prevention, control, and countermeasure ("**SPCC**") plan in accordance with EPA requirements. This shall include a construction-phase SPCC plan and operational-phase SPCC plan, respectively.

2.4.2 **Contractor shall upload electronic copies of all Contractor Deliverables (including drafts and final) to Owner's web-based document management site. Further, Contractor shall designate a document control lead to work with Owner's document control lead towards the timely, efficient, and organized submittal of documents.**

2.4.3 **Contractor shall prepare and maintain a documentation list for the Project. This list shall include, at a minimum, a listing of all Contractor Deliverables and the status (including responsible party) and revision number of each. The naming and labeling conventions for all Contractor Deliverables shall be coordinated with and approved by Owner. The documentation list shall be updated by Contractor each time a new or revised drawing or document is issued, at a minimum, including identifying any open and/or pending submittals for review.**

2.4.4 **Contractor shall prepare and maintain a complete log, including supporting documentation, of all requests for information (each, an "RFI") issued throughout performance of the Work. This log shall include, at a minimum, a listing of each RFI and the status (including responsible party) and revision number of each. The naming and labeling conventions for all RFIs shall be coordinated with and approved by Owner. The documentation list shall be updated by Contractor each time a new or revised RFI is issued, at a minimum.**

2.4.5 **Contractor shall provide to Owner periodic written reports as to the actual progress of the Work in comparison to the Project Schedule. These reports shall include, but are not limited to, the plan of the day report, the weekly progress report, and the monthly progress report.**

2.4.6 **Contractor shall maintain color hard copies of all issued-for-construction drawings at the Project Site during performance of the Work, including at least one (1) complete set in Owner's office trailers; such hard copies shall be updated by Contractor upon issuance of any revised issued-for-construction drawing. Contractor shall maintain separately a complete set of controlled redline drawings showing all Owner-approved changes made during construction, including reference to the applicable RFI number; such redlines shall be included in the Job Books.**

2.5 Signage

2.5.1 **Contractor shall furnish, install, and maintain throughout the performance of the Work all signage required by the Applicable Permits, the Applicable Standards, and other applicable Requirements. All signage and equipment marking (including numbering and labeling) shall be approved by Owner prior to installation.**

2.5.2 **Contractor shall furnish and install (a) a permanent sign at each Wind Turbine listing the name of the Wind Turbine; and (b) identification numbers and permanent, weatherproof labels on the base of all Wind Turbine towers, indicating Owner tower number and Collection System Circuit number, respectively.**

2.5.3 **Contractor shall furnish and install identification numbers and permanent, weatherproof labels on all Interconnection Line structures.**

2.5.4 **Contractor shall furnish, install, and maintain above-ground "buried cable" marker signs (a) at all locations where an underground Collection System Circuit crosses a road, fence, or underground utility respectively; (b) at a minimum of every 2,000 feet of trench length; and (c) at all sharp turns in the Collection System Circuits.**

2.5.5 **Contractor shall furnish and install a permanent, free-standing, non-masonry sign at the O&M Building location indicating Project name, Owner name, and entry requirements. The location, contents, and format of this sign are subject to Owner approval.**

2.5.6 **Contractor shall furnish and install a permanent sign on the fence at the Project Substation entrance. This sign shall indicate Project name, Project Substation name (if applicable), Owner name, and contact information. The location, contents, and format of this sign are subject to Owner approval.**

2.5.7 **Contractor shall furnish and install "no trespassing" signs at access road entry points and permanent speed limit signs at intervals of no greater than two (2) miles along all Project access roads.**

2.5.8 **Contractor shall, prior to the start of construction activities, measure the height of all overhead power lines or obstructions at the Project Site. Contractor shall furnish, install, and maintain signage at each such crossing and incorporate any measures necessary to operate, move, and mobilize cranes and other equipment to ensure safe passage with adequate clearance.**

2.5.9 **Contractor shall furnish, install, and maintain signage as needed for blind corners, dips, trucks entering roadways, restricted areas, and other potential hazards. Contractor shall also furnish, install, and maintain danger signs, signals, lights, guard rails, reflectors on curves, and notices as may be necessary to adequately protect the Work and personnel of any company at the Project Site, including visitors, against injury or property damage. All such signage shall be installed prior to commencing construction activities.**

2.5.10 **Contractor shall furnish, install, and maintain signage as needed to provide reasonable information and direction to Project Site personnel and to facilitate orderly entrance and egress from the Project Site. Contractor shall also furnish, install, and maintain signage identifying personnel assembly locations for use during emergencies or Project Site evacuations.**

2.5.11 **Contractor shall furnish and install emergency response (E-911) address signs in accordance with local authorities.**

2.5.12 **Contractor shall uninstall, remove, and discard of all temporary signage at the completion of the Work, or as otherwise prescribed in the Applicable Permits. Temporary signage shall be legible and of sufficient durability to last the duration of construction activities.**

2.6 Permits

2.6.1 **Contractor shall obtain, pay for, and maintain all permits required for its performance of the Work including, but not limited to, the siting, zoning, wetland and building/construction-related permits required for the construction of the Project. Contractor shall provide copies to Owner of all permit applications for Contractor Permits promptly after such applications are submitted to the applicable authority.**

2.6.2 **Contractor shall maintain copies of all permits at the Project Site during construction of the Project and shall at all times comply with all requirements of Contractor Permits, including closeout of such permits, and shall transfer to Owner such permits required for the operation and maintenance of the Project.**

2.6.3 **Contractor shall provide reasonable assistance, including engineering support, to Owner in applying for, obtaining, and maintaining the Owner Permits.**

2.7 Training

2.7.1 **Contractor shall prepare and conduct comprehensive training of Owner and its operations and maintenance personnel in the safe operation and maintenance of the Project and its equipment, as further described in Exhibit [●] *(Contractor-Provided Training)*. Such training shall cover, at a minimum, the Project Substation, the Collection System Circuits, the Communications System, the Interconnection Line, the O&M Building, and the meteorological towers.**

2.7.2 **Contractor shall provide regular and ongoing lockout-tagout training to on-Site personnel throughout the performance of the Work.**

2.8 Temporary Facilities

2.8.1 **Contractor shall furnish and install one (1) 24-foot by 60-foot double-wide office trailer for Owner's exclusive use. Each trailer shall be located at the laydown yard and shall be installed and ready-to-use no later than 10 days after the Contractor mobilization date or on the same date when Contractor's trailers are installed, whichever occurs first. Owner's trailer(s) shall be removed from the Project Site at Project Substantial Completion or when Contractor's trailers are removed from the Project Site, whichever occurs last.**

(1) Each trailer shall include at least four (4) offices, and Contractor shall furnish each such office with two (2) desks, two (2) two-drawer file cabinets, two (2) rolling arm chairs, two (2) visitor chairs, and one (1) 4-foot by 6-foot white board.

(2) Each trailer shall include at least one (1) conference area, and Contractor shall furnish each such conference area with six (6) 8-foot-long tables, 16 chairs, and one (1) 4-foot by 6-foot white board.

(3) Each trailer shall include at least one (1) unisex restroom, each complete with one (1) flushable toilet and one (1) sink.

(4) Each trailer shall include at least one (1) full-size drawing table, one (1) full-size drawing rack, and two (2) 4-foot by 6-foot bookshelves, respectively.

(5) Each trailer shall include one (1) full-size refrigerator with freezer and one (1) full-size microwave. All appliances shall be new and unused.

(6) Each trailer shall be furnished with central HVAC.

(7) Each trailer shall be furnished with at least one (1) first aid kit and one (1) fully-charged fire extinguisher, respectively. Contractor shall maintain and recharge such fire extinguishers throughout the duration of the construction activities, as required.

(8) Each trailer shall be furnished with a wifi-enabled printer that includes scanning capabilities, and with 8.5-inch by 11-inch and 11-inch by 17-inch print sizes.

(9) Contractor shall furnish and install phone service, broadband internet service, and electric service for each Owner trailer, including connection of all communications (phone and internet) to the jobsite. Phone service may be VoIP and shall include at least one (1) four-line phone system up to the wall jacks in each trailer. Internet service shall include high-speed internet infrastructure wiring up to the wall jacks in each trailer and high-speed wireless internet service (wifi) throughout the trailer compound, respectively. All utility services shall include use and service charges to Contractor's account, including for Owner's trailers.

(10) Contractor shall furnish bottled water and ice in each Owner trailer and for Owner's exclusive use throughout the duration of the construction activities.

(11) Contractor shall provide weekly cleaning services within each Owner trailer throughout the duration of the Work. This shall include cleaning restrooms and trash collection, pickup, and removal, respectively.

2.8.2 **[NTC: confirm requirements for Turbine Supplier's trailer(s) and add here, if any, including requirements for utility services. Sample: Turbine Supplier shall furnish and install two (2) 24-foot by 60-foot office trailers for Turbine Supplier's exclusive use. Contractor shall provide and install phone service (minimum five (5) outgoing lines), internet service (wifi), and electric service (110V and 220V AC) for each Turbine Supplier trailer, including making all connections to the trailer, up to and until Contractor's Substantial Completion date. All use and service charges for utility services for Turbine Supplier's account shall be paid by Contractor..]**

(1) [NTC: Sample: *Turbine Supplier's trailer shall include a minimum of two (2) offices, a center space large enough for a 10-person conference table, central HVAC, and electrical outlets.*]

2.8.3 **[NTC: Sample: *Contractor shall furnish and install phone service, internet service, electric service, [and running water] for each Turbine Supplier trailer, including connection of all communications (phone and internet) to the jobsite. All utility services shall include use and service charges to Contractor's account, including for Turbine Supplier's trailer.*]Contractor shall provide separate office trailers for their own use. Contractor shall be solely responsible for furnishing their trailer(s), including any utility services.**

2.8.4 **Contractor shall furnish, install, and maintain portable chemical toilets for use by site construction personnel, including Owner, Turbine Supplier, and subcontractors. This shall include cleaning (at least weekly), emptying, and disposal of such toilets through substantial completion of the Project or Contractor demobilization, whichever occurs last. Following such date, Contractor shall remove all such toilets from the Project Site.**

2.8.5 **Contractor shall design, permit, furnish, construct, and maintain, as required, any temporary fuel containment facilities required to support ongoing construction activities. This shall include removal of all such facilities following substantial completion of the Project or Contractor demobilization, whichever occurs last.**

2.8.6 **Contractor shall design, permit, furnish, construct, and maintain (including disposal), as required, any hazardous materials/waste facilities required to support ongoing construction activities. This shall include removal of all such facilities following substantial completion of the Project or Contractor demobilization, whichever occurs last. Contractor shall provide Owner with a copy of all hazardous material manifests.**

2.8.7 **As required to perform the Work, Contractor shall procure, permit, install, construct, and maintain batch plant(s) at the Project Site, including all necessary labor and materials related to the operation of the batch plant, and removal of the batch plant at the conclusion of the Work. The batch plant shall be removed from the Project Site by Contractor within 30 days of the final Project concrete pour utilizing the batch plant, not to occur after substantial completion of the Project. Power to operate the batch plant shall be the sole responsibility of Contractor.**

2.8.8 **As required to perform the Work, Contractor shall procure, permit, install, construct, and maintain fixed and/or mobile rock crusher(s) at the Project Site, including all necessary labor and materials related to the operation of the rock crusher(s), and removal of the rock crusher(s) at the conclusion of the Work. The location of any fixed rock crusher(s) shall be at the temporary facility areas, and the location of any mobile rock crusher(s) shall remain within the designated disturbance areas. Power to operate the rock crusher(s) shall be the sole responsibility of Contractor.**

2.8.9 **Contractor shall design, furnish, construct, install, and maintain one (1) temporary laydown yard.**

(1) The laydown yard shall be constructed at a location at the Project Site to be approved by Owner.

(2) The laydown yard shall be approximately 10 acres in size to allow for simultaneous (a) storage of equipment except for major turbine components, including any Owner-Supplied Equipment, that will not be stored at the Wind Turbine Pads; (b) storage of office trailers and other temporary facilities; (c) portable restrooms, including for Turbine Supplier; (d) parking for approximately 20 Owner vehicles and approximately 15 Turbine Supplier vehicles, respectively; (e) regular construction traffic; and (f) space for the long term needs of Turbine Supplier. Contractor shall incorporate this into the design and construction of the laydown yard. To the extent that 10 acres is not sufficient for the aforementioned purposes, any additional acreage required shall be Contractor's sole responsibility to obtain and maintain, unless requested by Owner.

(3) The laydown yard shall be covered throughout with at least six (6) inches of aggregate over a compacted subgrade. The maximum aggregate size shall not exceed three (3) inches.

(4) The laydown yard shall be graded to drain and shall not exceed two percent (2%) grade, or less if required for the safe storage of equipment or to meet manufacturer's requirements for storage of equipment.

(5) Fencing and gates are not required for the laydown yard.

(6) The laydown yard shall comply with the Turbine Supplier Project Site Requirements.

2.9 Debris

2.9.1 **Contractor shall assume ownership of all construction-related debris and unsuitable materials generated by Contractor, and each shall be removed from the Project Site and be properly disposed of by Contractor.**

2.9.2 **Contractor shall maintain a continuous and regular clean-up program to avoid accumulation of debris, waste, wreckage, and/or rubbish within the Project Site resulting from the Work and shall maintain the Project Site in a neat and orderly condition throughout the performance of the Work.**

2.9.3 **Contractor shall provide all trash collection, pickup, and removal related to the Work, including within Owner's office trailers and other temporary facilities, and including disposal of cable reels. Dumpsters and trash receptacles shall be provided in sufficient quantities and with sufficient volume to support timely trash removal from the Project Site and preclude windblown trash generated during construction activities. Dumpsters and trash receptacles shall be emptied at a reasonable frequency to prevent overflowing or accumulation of trash around the dumpster or receptacle. For the avoidance of doubt, Turbine Supplier shall be provided with access to utilize such receptacles.**

2.9.4 **Contractor shall cause its subcontractors, employees, and other representatives to refrain from littering at or within the Project Site, or within other areas (including along public roadways) used in conjunction with the Work.**

2.9.5 **Contractor shall use lined washout pits, washout dumpsters, or other suitable means to contain the excess concrete and runoff from the cleaning of concrete trucks. All washout waste shall be properly disposed of off-Project Site by Contractor in accordance with the Requirements.**

2.10 Logistics

2.10.1 **Contractor shall furnish and deliver all equipment to the Project Site.**

2.10.2 **Contractor shall perform all off-Project Site clearing necessary for the transportation of equipment to the Project Site, including, but not limited to, tree trimming / removal and clearing of overhead obstructions. Contractor shall also upgrade and maintain public roads, bridges, and culverts as required for the transportation of equipment to the Project Site and including obtaining any necessary permits.**

2.10.3 **Contractor shall perform all clearing at the Project Site necessary for the transportation of Wind Turbines at the Project Site, including, but not limited to, tree trimming / removal, clearing of overhead obstructions, and utility line drops along county roads and access roads. However, notwithstanding the foregoing and except as otherwise stated herein, Contractor has not included any widening of public roads or upgrades / modifications to bridges necessary for the delivery of Owner Furnished Equipment.**

2.11 Coordination

2.11.1 **Contractor shall actively coordinate the sequence of Work with Owner and Owner's Contractors to support the Project Schedule. For the avoidance of doubt, this shall include coordination with Turbine Supplier's schedule for the delivery and commissioning of Wind Turbines. Contractor, Owner, and Turbine Supplier shall meet (a) on a weekly basis before Wind Turbine deliveries begin and (b) daily after Wind Turbine deliveries begin; the purpose of such meetings shall be to coordinate schedule for delivery and commissioning of the Wind Turbines. On a weekly basis, a meeting shall be held to reconcile all demurrage and delays for all parties regarding deliveries and offloading of components.**

2.11.2 **Contractor shall coordinate with all transportation Contractors to mitigate congestion within the Project Site. Contractor shall provide directions to the Project laydown yard to all heavy load transportation vehicles upon arrival to the Project Site and, if required by the transportation plan, Contractor shall provide an on-Project Site vehicle escort for all such deliveries to the respective delivery location(s).**

2.11.3 **Owner shall be responsible for obtaining necessary crossing permits or agreements for local utilities and pipelines. Contractor shall coordinate with local utilities and pipeline companies to facilitate crossings and interconnections necessary to perform the Work, including contacting such entities as set forth in Section 2.3.9 herein.**

(1) Contractor shall provide pipeline / underground utility owners with at least 48 hours advanced notice prior to any construction or excavation work upon the easement area for their pipelines.

2.12 Project Site Closeout and Restitution

2.12.1 **Contractor shall document and repair all drain tiles damaged during performance of the Work, including during road installation, Collection System Circuit installation, Turbine Foundation installation, crane walks, or otherwise. Repairs shall be consistent with or better than the original tile installation.**

2.12.2 **Contractor shall remove all tools, equipment, surplus materials (including unused or useless materials), waste materials, temporary work (including temporary erosion control features), temporary buildings, temporary facilities (including batch plants, rock crushers, and office trailers), and rubbish from the Project Site prior to final completion, and shall cause any facilities used by Contractor during the performance of the Work to be restored to the same or better condition that such facilities and the Project Site were in on the date the Contractor commenced work at the Project Site, ordinary wear and tear excepted.**

2.12.3 **Contractor shall perform restitution, restoration, and/or reclamation of Work areas to include, but not limited to, the following. Notwithstanding anything that follows, all Work areas at the Project Site shall be restored, at a minimum, in accordance with the requirements set forth in the Applicable Permits, the SWPPP, and the other Requirements, as appropriate, and shall be fully restored to their pre-construction condition, at a minimum.**

(1) Clean all drains and ditches at completion of the construction Work, including removal of silt and debris from culverts, and leave the Project Site in a neat and presentable condition wherever construction operations have disturbed the conditions existing at the time of starting the Work.

(2) Preserve and/or restore to their pre-construction condition all land and water resources adjacent to construction areas.

(3) Notwithstanding the following paragraph (a), Crane pads (non-graveled sections), laydown areas (including the laydown yard), roadway shoulders, and roadway turning radii shall be decompacted and reclaimed, including proper grading, aggregate touchup, and seeding with an approved mixture. For the avoidance of doubt, such areas shall not be reclaimed until applicable Wind Turbine erection activities have been completed.

(a) Crane pads shall be preserved in a suitable manner to support the use of cranes in ongoing Wind Turbine maintenance activities following construction (e.g., cranes required for gearbox removal and / or installation) per the following requirements:

1. Preserve a 50-foot-long by 40-foot-wide portion of the geotextiled and graveled crane pad with the 50-foot dimension corresponding with the axis parallel to the adjacent access road. The width of the adjacent access road may be included in the 40-foot measurement.

(4) Pending coordination with landowner, County, or other right-of-way owner, improved roadway turning radii shall remain in place. If laydown yard is part of the O&M Building yard, it shall be left in place, otherwise laydown yard shall be reclaimed.

(5) Re-dress all Contractor-installed and Contractor-affected road surfaces within the Project Site such that the final cross section meets the specifications provided in the IFC civil drawings and such that all roadway surfaces are graded for drainage and low spots are removed.

(6) Seed all cut / fill slopes utilizing an approved seed mixture. Seeding shall occur during a time / season when the probability of successful seed germination is maximized; hydro-seeding is acceptable for slopes.

(7) Fill all depressions and water pockets caused by construction operations and remove all obstructions within waterways.

(8) Spread surplus fill on-Project Site in areas and depths approved by Owner.

(9) Spread recovered aggregate from laydown yard within approved disturbance limits at Owner-approved locations including but not limited to on access roads, beauty rings, and/or the O&M Building yard.

(10) In all areas, collect rocks, defined as four (4) inches in diameter or larger, unearthed during excavation as part of the Work and separated using a rock bucket, but not utilized in the construction of the Project and store at Owner-approved locations.

3.0 GEOTECHNICAL SERVICES

3.1 General Provisions

3.1.1 **Contractor shall conduct all geotechnical, geophysical, and other similar subsurface investigations and testing necessary for the complete engineering, procurement, and construction of the Project. For the avoidance of doubt, all such investigations shall be completed before commencing the applicable Work.**

3.1.2 **All Work concerning the geotechnical services shall be supervised and directed by a qualified, competent, practicing geotechnical engineer. A geotechnical engineer or engineering geologist shall observe, log borings, obtain soil samples, and record blow counts of the samples, drill rates, rock quality, depth to ground water, and other pertinent data under the direction of a licensed geotechnical engineer.**

3.2 Submittals

3.2.1 **Contractor shall submit to Owner, *prior* to initiating subsurface investigations, the name and qualification statement for proposed geotechnical engineer.**

3.2.2 **Contractor shall submit to Owner, *prior* to initiating subsurface investigations, the proposed scope of subsurface investigation, including number, location, and depths of borings; anticipated plan for laboratory testing; and detailed descriptions of additional site investigation techniques, including thermal and electrical resistivity or other necessary testing.**

3.2.3 **Contractor shall submit a complete geotechnical engineering report (the "Geotechnical Report") containing the required information summarized below, at a minimum. The Geotechnical Report shall be utilized for the design and construction of all Project structures, including Turbine Foundations.**

(1) Subsurface and groundwater conditions encountered.

(2) Description of the geology, including areas of landslides, potential landslides, potential geologic hazards, past (historical) earth movements, and transitions between geologic units; special consideration shall be given to identify active and potential landslide zones.

(3) Description of the drilling and sampling program.

(4) Field photographs.

(5) Boring coordinates, boring location drawings, and final boring logs.

(6) Summary of results of field and laboratory tests performed.

(7) Specific design criteria for the Project, including (a) impacts of new construction on existing facilities; (b) factors of safety used in determining allowable foundation loads; (c) recommended foundation types for all structures; (d) discussion of the dynamic soil properties at the Project Site, including dynamic shear modulus, Poisson's ratio, Young's Modulus, and shear wave velocity; (e) recommendations for designing for seismic issues, including liquefaction potential and the identified building code site coefficient/site classification for seismic design; and (f) recommendations for site dewatering and construction practices, including design water level.

(8) For shallow foundations, (a) allowable soil bearing values and minimum bearing depths; (b) anticipated total and differential settlements; (c) uplift resistance; (d) lateral resistance; (e) subgrade modulus; and (f) dynamic spring constants for foundations supporting vibrating machines, if applicable.

(9) For deep foundations, (a) type of deep foundation (e.g., drilled shaft, rock anchor); (b) diameter (or dimensions) and depth of foundation members; (c) minimum spacing and group reduction factors; (d) allowable compressive, uplift, and lateral capacities including allowable skin friction and end bearing capacities, anticipated settlements and lateral deflections; and (e) static and dynamic spring constants.

(10) Recommendations for slopes, including (a) temporary excavation slopes and OSHA soil types; (b) permanent slopes; and (c) temporary and permanent excavation support requirements.

(11) Corrosion potential and chemical attack to construction materials.

(12) Recommended cement type in concrete and corrosion protection for buried steel, based on chemical test results. Recommended cement type shall be based on soluble sulfate content in the soil and ACI recommendations.

(13) An evaluation of the expansive, dispersive, and collapsing nature of the on-Site soil materials and discussion of design features to resist these tendencies.

(14) Recommendations for earthwork including acceptable fill materials, moisture contents, compactive effort, lift thickness, proofrolling, equipment, and compaction testing, and recommended aggregate gradations for general fill, load bearing fill, granular road base, and granular surfacing.

3.3 Field Investigations

3.3.1 **Contractor shall drill geotechnical borings and conduct material sampling at the locations and minimum frequencies set forth below:**

(1) Wind Turbines: one (1) per Wind Turbine location.

(2) Project Substation: minimum of five (5) locations at the Project Substation.

(3) Interconnection Line: each engineered foundation location, each failure containment structure (if any), each angled (of 2 degrees or greater) and dead-end structure, respectively, as well as any additional borings and samplings necessary to ensure that adjacent borings are no more than one (1) mile apart.

(4) O&M Building: minimum of two (2) locations at the O&M Building.

(5) Meteorological towers: each free-standing meteorological tower location.

3.3.2 **Contractor shall perform electrical resistivity measurements at the minimum frequencies set forth below, in each case using the Wenner Four-Electrode method (ASTM G57) or Owner-approved equal, and in each case with final locations approved by Owner prior to testing:**

(1) Wind Turbines: ten percent (10%) of all Wind Turbine locations.

(2) Project Substation: one location near the center of the proposed substation footprint.

(3) Interconnection Line: minimum of one (1) location per mile.

(4) Collection System Circuits: minimum of one (1) location per circuit.

3.3.3 **Contractor shall perform thermal resistivity testing in accordance with ASTM D5334. Laboratory testing shall include a measurement of the soil's moisture content, maximum dry density, and thermal dryout characteristics. Thermal resistivity testing shall be conducted at the same frequency as electrical resistivity measurements in <u>Section 3.3.2</u> above.**

3.3.4 **Contractor shall obtain 24-hour water level readings in boreholes or install piezometers for long-term water level readings as required to determine prevailing groundwater levels.**

3.3.5 **Contractor shall perform any additional geophysical or other site investigations, including, but not limited to, standard penetration tests, Shelby tube samples, deepened borings, additional borings, test pits, seismic refractions, cone penetrometer soundings, *in situ* testing, and other similar or related methods, as necessary to supplement the required geotechnical investigations summarized herein or to otherwise provide the data and recommendations required in the Geotechnical Report.**

3.3.6 **Other boring and material sampling requirements:**

(1) Borings shall be backfilled with cement-bentonite grout and in a manner and with materials required under the Applicable Laws of the location of the Project Site. Excess cuttings shall be disposed of by Contractor in accordance with the applicable Requirements and subject to Owner approval, and the Project Site premises shall remain free from accumulations of waste materials or rubbish resulting from the geotechnical field investigations.

(2) Existing utilities near borings or other subsurface test locations shall be identified and protected.

(3) Each Wind Turbine boring shall be to a minimum depth of the greater of (a) 35 feet; (b) at least one (1) foundation diameter for spread footer foundations; or (c) at least 10 feet beyond the anticipated depth of the foundation at such location (including anchors, if applicable) for rock anchor foundations. All other borings shall be to a depth of at least 35 feet below the base of the applicable foundation / structure.

(4) Sufficient rock core samples shall be obtained from each boring to adequately characterize and test the material, including coring from the point at which competent rock is encountered and until the appropriate boring depth is achieved (at a minimum). All core samples shall be delineated and digitally photographed in color. Unaltered rock core samples shall be placed in a core box and taken to a laboratory for analysis.

(5) If using rock anchor foundations, Contractor shall perform a rock analysis to identify the presence of fissures, rock joints, or other discontinuities that will control the overall strength of the rock mass, including, but not limited to, rock mass rating, rock classifications, depth of overburden, rock quality designation, joint spacing and orientation, stratifications, rock material strength, and water pressure in joints.

3.4 Lab Testing

3.4.1 **Contractor shall perform all laboratory testing necessary to classify the materials and to obtain physical characteristics of the subsurface materials. At a minimum, laboratory testing shall include (a) moisture content per ASTM D2216; (b) grain size analysis per ASTM D422; (c) dry unit weight tests per ASTM D7263; (d) Atterberg limits per ASTM D4318; (e) unconfined compressive strength per ASTM D2166; (f) compaction characteristics / standard proctor density of the soil per ASTM D698; (g) soil corrosiveness (chloride, sulfate, and pH) per ASTM D4972 and USEPA methods; (h) unconsolidated-undrained triaxial compression per ASTM D2850; (i) direct shear per ASTM D3080; (j) one-dimensional consolidation per ASTM D2435; (k) one-dimensional swell or collapse of soils per ASTM D4546; and (l) thermal resistivity testing per ASTM D5334.**

3.4.2 **All testing described herein shall be performed by an independent, experienced third party.**

4.0 CIVIL / STRUCTURAL WORKS

4.1 General Provisions

4.1.1 **All civil / structural works, including, but not limited to, access roads, Turbine Foundations, Wind Turbine Pads, and the laydown yard, shall conform to Turbine Supplier's requirements for roads, crane pads, and hardstands, as set forth in Exhibit [●] (*Turbine Supplier Project Site Requirements").***

4.1.2 **All permanent drainage facilities, including culverts, low-water crossings, ditches, and swales, shall be designed and constructed to withstand a 10-year, 24-hour storm event.**

4.1.3 **The design working life of the Turbine Foundations shall be a minimum of 30 years.**

4.1.4 **Requirements for access road crossings:**

(1) All access road crossings, including public roads, railroad, pipeline, utilities, and property lines, shall be as close to ninety degrees (90°) as reasonably practicable. All access road crossings of buried facilities (e.g., pipeline, utility line) shall maintain at least 36 inches of cover.

(2) All access road crossings of buried facilities (e.g., pipeline, utility line) shall be marked on each side with an above-ground cable marker, each meeting the requirements in Section 5.1.12 below.

(3) Contractor shall coordinate with local utilities and pipeline companies as set forth in Section 2.11.3 herein.

4.1.5 **Requirements for site roads:**

(1) Roads shall be designed, constructed, and maintained adequately to support all anticipated construction loads, equipment delivery (including Wind Turbines and other Owner-Supplied Equipment), crane crawling, construction traffic usage (including concrete trucks), and weather conditions to be expected. Maintenance shall include the requirements set forth in Section 4.3.3 herein.

(2) Roads shall comply with the Geotechnical Report (for subgrade and cross-section requirements), the Turbine Supplier Project Site Requirements, and the drainage and erosion control requirements in Section 4.1.6 herein.

(3) Road entries, intersections, and turns shall be designed to accommodate the longest vehicle anticipated to utilize the road so that it will be able to maneuver through the entire Project Site without leaving the graveled road area. Cantilevered loads (e.g., Wind Turbine blade ends) shall be considered to ensure obstructions adjacent to the roadway are cleared and will not endanger the equipment delivery. Wind Turbine spur roads shall have a minimum turning radius of 25 feet from other roads at final construction.

(4) Roads shall be a minimum of 16 feet wide, except for meteorological tower roads which shall only be 12 feet wide. Where crane walks are to be utilized, roads shall have a minimum 10-foot temporary compacted earthen shoulder on each side. Roads shall be widened through turns and curves, as necessary.

(5) Roads shall be covered with at least six (6) inches of [add DOT size/type based on project location] aggregate over a compacted subgrade, including geotextile fabric (or equivalent) as required. The maximum aggregate size shall not exceed two (2) inches, shall include appropriate fines, and shall conform to local department of transportation requirements. The subgrade shall be cleared and compacted to at least ninety-five percent (97%) of the maximum density within the moisture content of two percent (2%) below optimum to two percent (2%) above optimum, as determined by ASTM Standard D698. [RFP Clarification: DOT size/type to be updated with Project location.]

(6) Cement stabilization of access road subgrade may be utilized in lieu of geotextile at predetermined locations, pending Owner review and acceptance. Cement stabilization shall be performed in accordance with recommendations and requirements set forth in the Geotechnical Report.

(7) Roads shall be designed and constructed with a maximum grade of eight percent (8%). Approaches to Wind Turbine Pads from access / spur roads shall be designed and constructed sufficiently level to allow transport vehicles, including Wind Turbine transport vehicles, to park on a flat surface during offloading.

(8) Maximum vertical crest and dip on roads is six (6) inches vertical to 50 feet horizontal, or less if required by the Turbine Supplier Project Site Requirements.

(9) The longitudinal radii (convex or concave) of roads shall not be less than (a) 750 feet or (b) a "K" value of 16.5.

(10) Roads shall be designed with turnarounds to assist in truck and trailer flow throughout the Project Site, as well as lay-bys as required by the Turbine Supplier Project Site Requirements. Backup motions for tractor trailers shall be kept to a minimum and are subject to Owner approval; if backup motions for tractor trailers are necessary, the backup path shall be as straight and short as possible. Dead-end roads shall be designed with adequate turnaround space for a tractor/trailer to turn around; cleared Wind Turbine Pads are suitable for this purpose provided any non-graveled areas present a suitable driving surface.

(11) Roads shall be cleared of overhead obstructions (e.g., power lines) as necessary to complete the Work, including to support Wind Turbine deliveries.

(12) Proof rolling shall be performed in the presence of a qualified, competent, practicing geotechnical engineer or their qualified representative. Proof rolling shall be performed using a fully-loaded tandem-axle truck with a minimum gross weight of 25 tons. An acceptable proof roll shall produce rutting of no greater than 1.5 inches and no "pumping" of soil beneath and/or behind the wheels of the loaded truck.

(13) Roads shall meet all required design elements at Substantial Completion (as defined in the Agreement). For the avoidance of doubt, this shall include replenishing road aggregate, repairing road damage, restoring road cross sections, repairing subgrade damage, and other loss of strength or stability that may have occurred during the course of construction.

4.1.6 **Contractor Requirements for drainage and erosion control:**

(1) The working areas of the Project Site shall be well drained during and after construction, respectively. All drainage shall be away from buildings and foundations.

(2) Roadway cross sections shall be shaped to move water away from the road, such as crowning or cross-slopes, and roads shall be designed and constructed to prevent water ponding. Roads shall have no more than two percent (2%) crown / side slope, unless such roads will be utilized as crane paths, in which case the maximum crown / side slope shall be one percent (1%). All roadways, including shoulders, shall be graded to self-drain and must not allow water to puddle and all roadways shall have a minimum crown / side slope of one percent (1%) to promote drainage.

(3) Storm water shall not channel flow across constructed roads and a self-draining ditch shall be constructed on the high (cut) side of roadways. Sheet flows shall be collected and conveyed to culverts or channels to safely pass storm water flows.

(4) Erosion and sediment control, both during and after construction, shall be provided as required by the Requirements and the Contractor-provided SWPPP to retain sediment onsite and to control the erosion of embankments, temporary and final exposed slopes, and temporary stockpiles, as well to protect water quality as applicable. Silt fences, check dams, drainage ditches or swales, straw mulch, and pre-manufactured geotextiles, geotubes, geogrids, cellular geoweb, and other similar items (collectively, the "**Best Management Practices**") shall be utilized as appropriate.

(5) All storm water flows shall be returned to their original drainage patterns and the Project shall not increase flow rates from their historic levels.

(6) Culverts or low-water crossings shall be installed / constructed where required, per Owner approval, to pass existing storm water concentrated flows. Culvert pipe ends, swales, and ditches shall be designed and constructed to control concentrated flow velocities and minimize erosion and siltation. Only culverts shall be used at entrances; low-water crossings are not allowed at entrances.

(7) Wetlands impacts shall be avoided to the maximum extent practicable and are subject to regulatory approval or other applicable Requirements.

(8) Synthetic, toxic, or otherwise harmful erosion-control materials shall be made inaccessible to livestock on or adjacent to the Project Site during the construction period.

4.1.7 **Requirements for excavation, fill, and backfill:**

(1) Materials suitable for use as fill at the Project Site shall include only materials that are free of debris, roots, stumps, organic matter, frozen matter, coal, ashes, cinders, stones larger than two (2) inches in diameter, slag, other deleterious materials, and as recommended by the Geotechnical Report. Surplus fill shall be spread on-Site and in areas and depths approved by Owner; surplus materials shall not be exported off-Site without the approval of Owner.

(2) Permanent slope and rock stability measures shall be part of the Project design and shall incorporate the recommendations and requirements set forth in the Geotechnical Report. Safe stabilization for all slopes, regardless of the type of rock or soil conditions, shall be guaranteed including protection of all personnel and structures against any damage from cave-ins, heaving, or other earth movements.

(3) Structural fill lifts shall not exceed a thickness of 8 inches. Other fill lifts shall not exceed a thickness of 12 inches.

(4) Turbine Foundation embedment depth shall consider final height requirements for the applicable Turbine's FAA DNH letter.

4.1.8 **Requirements for fencing and gates:**

(1) All permanent fencing and gate materials, including for the Project Substation, O&M Building, and meteorological towers, shall be constructed in accordance with Exhibit 6 – MP Site Construction Specification - Fence. All permanent fencing shall be appropriately grounded.

(2) Unless stated otherwise, permanent fencing shall be 10-foot-high (9-foot fence plus 1-foot barbed wire), anti-climb, chain link, perimeter fencing with 9-gauge, 2-inch diamond mesh. Permanent fencing fabric / slats are not required.

(3) Barbed wire shall be a minimum of 2-strand, #12-1/2 steel wire gauge with 4 point round barbs of #14 steel wire gauge at 4-inch spacing. After weaving, the wire shall be galvanized per ASTM A121. Barbed wire fencing posts shall be galvanized, standard-weight steel pipe. At least four (4) lines of barbed wire shall be provided when used.

(4) Gate widths shall be consistent with road widths, wherein all gate posts shall be set outside of the road width area. Sufficient space and graded area shall be provided near each gate to allow truck turning.

(5) All gates shall adequately contain livestock without being pushed open, bending, or otherwise failing, and all gates shall adequately prevent opening due to wind conditions expected at the Project Site.

(6) All corner posts and gate posts shall be steel and shall be set (embedded) in concrete. Other fence posts shall be direct-embed galvanized t-posts.

(7) Cattle guards shall (a) cover the full road width; (b) be installed level; and (c) be provided with a stable base capable of sustaining heavy loads without shifting or settling.

(8) Each temporary gate shall match the existing fence materials, and the existing fencing shall be reestablished at the end of construction activities.

(9) All existing livestock fences within 100’ of any construction area shall be surveyed prior to construction.

(10) Fence posts or other embedded fence components must be located at minimum distances from local utilities and pipelines as per utility and pipeline owners’ requirements.

4.1.9 **Requirements for structures:**

(1) All buildings, support structures, foundations (including Turbine Foundations), and equipment pads shall be constructed on competent material. All loose materials shall be removed from excavation bottoms. Unsatisfactory foundation subgrade material shall be removed and replaced with compacted structural fill material or with suitable concrete.

(2) Foundation designs shall neglect or degrade soil strength properties at the top of the foundation as a result of frost or disturbance during drilling per recommendations of the geotechnical engineer. All foundations shall be designed with consultation of a licensed geotechnical engineer.

(3) All foundations and slabs-on-grade shall have a minimum projection (reveal) of 6 inches above ground level, except that concrete pier-type foundations shall have a minimum projection of 12 inches of concrete above ground level.

4.1.10 **Requirements for concrete:**

(1) Concrete for Turbine Foundations shall have a minimum specified compressive strength of 5,000 psi and any other structural concrete (including all Project Substation concrete) shall have a minimum specified compressive strength of 4,500 psi. Non-structural concrete shall have a minimum specified compressive strength of 2,000 psi.

(2) Concrete mix designs and concrete placement procedures shall be approved by Owner prior to use; see Section 4.2.5 herein for mix design requirements. Concrete shall be placed only in the presence of a duly-authorized representative of Contractor. A successful break test showing the minimum specified compressive strength(s) shall be provided from the concrete source(s), including an on-site batch plant if applicable, at least five (5) days prior to placing concrete from such source(s).

(3) If allowed by the engineer of record, fly ash may be used to replace up to a maximum of 25 percent (25%) of cementitious material content by weight. If used, fly ash shall be in accordance with ASTM C618 and shall be Class F; Class C fly ash shall not be used without Owner approval.

(4) Aggregates shall be tested per ASTM C33 for potentially reactive materials. If such test results indicate that aggregates are reactive, an alkali-silica reaction ("**ASR**") mitigation plan shall be provided.

(5) Concrete shall be placed at a sufficient rate to ensure that lifts below have not taken initial set before fresh concrete is deposited. In any event, concrete shall be placed within 45 minutes after mixing. This period may be extended to 90 minutes provided that the combined air temperature, relative humidity, and wind velocity are such that the plasticity of the fresh concrete is satisfactory for placement and consolidation, and that the specified mixing water is not exceeded. Concrete which has partially set shall not be retempered but shall be discarded.

(6) Concrete placement shall not be permitted when weather conditions or other pertinent factors prevent proper placement and consolidation. Hot weather concreting shall be in accordance with ACI 305R. Cold weather concreting shall be in accordance with ACI 306R.

(7) The maximum aggregate size for concrete shall not exceed 1.5 inches. Smaller maximum aggregate size, such as 0.75 inches, may be necessary for pumped or tremie concrete. Rounded aggregates may be necessary to produce desired workability.

(8) All exposed foundation edges shall include a 0.75-inch chamfer.

(9) Immediately after depositing, concrete shall be compacted by agitating thoroughly in an approved manner to force out air pockets. The mixture shall be worked into corners around reinforcement and inserts to prevent formation of voids. Tapping or other external vibration of forms will not be permitted. Care shall be used in use of vibrators to prevent segregation of sand pockets or bleeding. Vibrators shall be moved continuously in and out of concrete, keeping stationary only a few seconds in any position. Vibrators shall not be used to transport concrete within forms.

(10) Maximum water/cement ratio: 0.45.

(11) Turbine Foundations shall not have joints, unless approved by Owner and only for the base and pedestal interface in a spread footer foundation. Where allowed, the joint surface shall be level and reasonably rough, clean, moist and some aggregate particles should be exposed. Any laitance or soft layers shall be removed from the top surface of the hardened concrete.

(12) All fins and other surface projections shall be removed from all formed surfaces.

(13) Surfaces that will be exposed shall be cleaned and rubbed to produce a smooth, uniform surface that is free of marks, voids, surface glaze, and discoloration. Slab foundations shall receive a light broom finish (or equivalent). Care shall be taken to see that all excess water is removed before making any finish.

(14) Concrete shall be protected from loss of moisture by membrane curing compound and the curing medium shall be maintained to prevent detrimental loss of water from the concrete for the duration of the entire curing period. An Owner-approved curing membrane shall be applied in accordance with manufacturer's recommendations as soon as the water sheen has disappeared from the concrete surface and following finishing operations, with an application rate of not less than 1 gallon per 200 square feet. If hot weather concreting is performed and an evaporation retardant is used, this retardant shall be applied prior to application of the curing agent, immediately following finishing of the concrete surface.

(15) Unhardened concrete shall be protected from heavy rains, flowing water, excessive heat, excessive cold, or mechanical damage. Finished surfaces shall be protected from stains, abrasions, or physical damage.

(16) All concrete which is porous, honeycombed, or otherwise defective (including conditions which adversely affect durability, strength, and/or appearance) shall be repaired. Defects in formed concrete surfaces shall be repaired within 24 hours, and defective concrete shall be replaced within 48 hours, after the adjacent forms have been removed. Defective concrete shall be repaired by chipping out the unsatisfactory material to a minimum depth of 0.5 inches and placing new concrete, which shall be formed with keys, dovetails, or anchors to attach it securely in place with Owner approval.

(17) Concrete testing:

(a) Prepare concrete test cylinders conforming to ASTM C31 prior to the first pour of each day and at a rate of not less than one set of cylinders for each 100 cubic yards or fraction thereof and not less than one set for each foundation or structure.

(b) Field slump tests in accordance with ASTM C143 shall be performed, at a minimum, prior to the first batch of concrete placed each day and with each set of test cylinders. Adjustment or fixing of concrete *in situ* shall not be allowed.

(c) Air content, concrete temperature, and air temperature tests shall be performed for the first batch of each day and with each set of test cylinders. All testing shall be done in accordance with the requirements of ASTM C231 (air) and ASTM C1064 (temperature).

(d) Electronic copies of concrete test reports shall be provided to Owner within 72 hours of testing but not less than 24 hours in advance of commencing Wind Turbine erection activities at the relevant Wind Turbine location. In the event of failure of any concrete test, Owner shall be immediately notified and a repair/remediation plan shall be provided.

(18) The Geotechnical Report indicates the presence of high sulfate content throughout different areas of the Project Site. All concrete design, including for Turbine Foundations, shall employ sulfate-resistant concrete, including Type V cement as appropriate. [NTC: confirm against the geotech report for individual project.]

4.1.11 **Requirements for grout:**

(1) Grout shall be (a) cementitious grout conforming to ASTM C1107 or (b) epoxy grout with a coefficient of expansion (as determined by ASTM C531) as determined by the Turbine Foundation engineer of record. All grout shall be non-ferrous, non-shrink, prepackaged/factory-packaged grout.

(2) Grout specifications and grouting plans/procedures shall be approved by Owner prior to use.

(3) Grouted surfaces that contain defects which adversely affect durability, strength, and/or appearance shall be repaired by a method approved by Owner or they shall be replaced.

(4) Grout test reports shall be provided to Owner within 72 hours of testing, and for Turbine Foundations, at least 24 hours in advance of commencing or continuing (as is the case with grouting of tower base sections) Wind Turbine erection activities at the relevant Wind Turbine location. In the event of failure of any grout test, Owner shall be immediately notified and a repair/remediation plan shall be provided.

(5) Any person who mixes and/or places grout below the Wind Turbine flange shall have received in-person, hands-on training from a representative of the grout manufacturer. Such training shall be received by each individual (a) with the Project-approved grout mix; (b) within the 12-month period preceding grout placement; and (c) *prior* to installation of grout.

4.1.12 **Requirements for forms:**

(1) Forms shall be substantial and sufficiently tight to prevent leakage and shall be properly supported and braced to maintain position and shape. Forms shall be designed to produce hardened concrete having the shape, lines, and dimensions indicated on the drawings, and forms for all exposed surfaces shall produce smooth, dense, and true finishes free of fins, imperfections, or other defects.

(2) Commercial formulation form-coating compounds shall be used that will not bond with, stain, nor adversely affect concrete surfaces, nor impair subsequent treatments of concrete surfaces requiring bond or adhesion, nor impede wetting of surfaces to be cured with water or curing compound.

(3) Formwork for walls, columns, sides of beams, gravity structures, slabs-on-ground, and other vertical-type formwork not supporting the weight of concrete shall remain in place for at least 24 hours after concrete placement is completed. Formwork supporting weight of concrete and shoring shall not be removed until structural members have acquired sufficient strength to safely support their own weight and any construction or other superimposed loads to which the supported concrete may be subjected.

(4) Forms may be of wood, plywood, concrete-form-grade hardboard, metal, or other acceptable material, which will produce smooth, true surfaces. Metal forms shall have smooth surfaces free from any pattern, irregularities, dents, or sags.

(5) Form ties shall be factory-fabricated, adjustable-length, removable or snap-off metal form ties, designed to prevent form deflection, and to prevent spalling concrete surfaces upon removal. For concrete that will be exposed, provide ties so portion remaining within concrete after removal is at least 1.5 inches inside concrete. Form ties shall not leave holes larger than one (1) inch in diameter in concrete surfaces.

(6) Remove forms in a manner to avoid damage to the structure, with particular care for corners and edges.

4.1.13 **Requirements for reinforcing bar:**

(1) All reinforcing bars shall conform to ASTM A615 and have a minimum yield strength of 60 ksi. All reinforcing steel, including welded wire mesh, shall be accurately located and held in position using proper reinforcing steel supports, spacers, and accessories in accordance with ACI SP-66 "*Detailing Manual*" and CRSI's "*Manual of Standard Practice*".

(2) At time of placing concrete, all reinforcing shall be free of loose rust, scale, oil, paint, mud or other coatings which may destroy or reduce the concrete bond.

(3) Where not otherwise specified, the minimum coverage of concrete over steel shall be as follows:

(a) Concrete cast against and permanently exposed to earth: 3 inches.

(b) Formed concrete exposed to earth or weather: 2 inches.

(c) Concrete in beams and columns not exposed to ground or weather: 1.5 inches.

(d) Concrete slabs and walls not exposed to weather: 1.5 inches.

(4) Concrete shall be placed at a consistent coverage thickness / depth over all rebar (e.g., all areas with a required minimum of 3 inches of cover shall have a consistent thickness of 3 inches, without significant increases).

(5) Concrete supports (dobies) shall have the same or higher compressive strength as specified for the concrete in which they are located.

4.1.14 **Requirements for anchor bolts:**

(1) Anchor bolts shall be properly located, accurately positioned, and maintained securely in place before placing of concrete. The threads on the upper end of each anchor bolt shall protrude sufficiently to satisfy the Requirements and adequately complete tensioning activities.

(2) Prior to setting anchor bolts, the threads on the upper end of each anchor bolt shall be given a light coat of oil or grease to prevent adherence of concrete. When installed, anchor bolts shall be cleaned and the portions to be embedded in concrete shall be cleaned and free of oil or other deleterious substances which would adversely affect the bond between the bolt and concrete, unless otherwise specified by Turbine Supplier or foundation engineer.

(3) During the concrete finish and clean-up, concrete adhering to the portions of the anchor bolt extending above finished concrete grade shall be removed giving particular attention to concrete at the finish grade line which would prevent base plates from seating fully on the finished concrete elevation.

(4) Following installation, anchor bolts shall be given an application of corrosion inhibitor and finished with bolt caps.

(5) Unless otherwise required by Turbine Supplier, anchor bolts, nuts, and washers shall comply with the following:

(a) Anchor bolts: ASTM A615 Grade 75 or A722 Grade 150, cold rolled threads, hot dip galvanize to ASTM A153.

(b) Nuts: ASTM A29 or ASTM A576, hot dip galvanize to ASTM A153.

(c) Washers: ASTM F436, hot dip galvanize to ASTM A153.

(6) Embedment rings shall be (a) minimum 1.5-inches thick; (b) ASTM A36, ASTM A529, or ASTM A572; (c) grade 50, minimum; (d) plain finish; and (e) new material (not reused).

(7) Template rings shall be a minimum 1-inch thick, ASTM A36 or ASTM A572 Grade 50, plain finish.

(8) Load spreading plates, if used, shall be (a) minimum 1.5-inches thick; (b) ASTM A36, ASTM A529, or ASTM A572; (c) grade 50, minimum; (d) galvanized; (e) new material (not reused); and (f) compliant with Turbine Supplier specifications. For galvanization, the plate shall be hot dip galvanized provided it does not adversely affect the flatness of the plate; otherwise, the protective finish shall be subject to Owner approval.

4.1.15 **Requirements for structural steel fabrication and connections:**

(1) Specific structural steel materials shall comply with the following, at a minimum:

(a) W-shapes: ASTM A992/A992M (50 ksi yield strength).

(b) Channels, angles-shapes: ASTM A36/A36M.

(c) Plate and bar: ASTM A36/A36M.

(d) Cold-formed hollow structural sections: ASTM A500, Grade B structural tubing.

(e) Steel pipe: ASTM A53/A53M, Type E or S, Grade B.

(f) Weight class: standard.

(g) Finish: galvanized.

(h) Welding electrodes: comply with AWS requirements.

(2) Structural steel shall be fabricated and assembled in shop to greatest extent possible.

(3) Design and fabrication shall be according to AISC's "*Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design*".

(4) High-strength structural steel shall be identified according to ASTM A6/A6M and maintain markings until structural steel has been erected. Materials shall be marked and match-marked for field assembly.

(5) Structural-steel assemblies shall be completed, including welding of units, before starting galvanizing operations.

(6) High-strength bolts shall be shop installed according to the RCSC's "*Specification for Structural Joints Using ASTM A325 or A490 Bolts*" for type of bolt and type of joint specified.

(7) Built-up sections shall be assembled and welded by methods that will maintain true alignment of axes without exceeding tolerances of AISC's "*Code of Standard Practice for Steel Buildings and Bridges*" for mill material.

(8) Weld connections shall comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding Work.

(9) Weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel shall be verified that they will limit distortions to allowable tolerances. Butt welds shall be ground flush. Exposed fillet welds shall be ground or filled to smooth profile. Exposed welds shall be dressed.

(10) Zinc coating shall be applied by the hot-dip process to structural steel according to ASTM A123/A123M.

(11) Vent holes shall be filled and ground smooth after galvanizing.

(12) Equipment support structures shall be low profile (non-lattice) framing consisting of galvanized structural steel tubing and rolled shapes as the basic structural element. Steel support structures shall be designed, fabricated, and erected in accordance with the provisions of the AISC.

4.2 Submittals

4.2.1 **Contractor shall prepare the civil works design documents per <u>The Submittal Schedule</u> and containing the following information, at a minimum: (a) design basis; (b) plan views of Project Site, including all access / site roads, crane paths, Wind Turbine locations, staging / laydown areas, Project Substation location, Interconnection Line route, Collection System Circuit routes, landowner names, landowner names, parcel statuses (participating, non-participating), easements, and public right-of-way; (c) Wind Turbine delivery flow plan; (d) profile views for all vertical curves; (e) grading and drainage plans; (f) details for erosion control, fencing, gates, compaction, road cross sections, road curves (horizontal and vertical), and Wind Turbine Pad cross sections; (g) properties for backfill / fill and road materials; (h) public road improvements; (i) drawing index; (j) inspection, testing, and quality control requirements; (k) pipeline crossings and (l) geospatial file (.SHP and/or .KMZ format) showing all Wind Turbines, meteorological towers, access roads, crane paths, and intersection improvements, at a minimum.**

4.2.2 **Contractor shall provide a hydrology study for the Project. Such study shall include a two-dimensional analysis of the Project area to determine specific flooding hazards (depth, velocity) at all locations within the Project Site boundary; such information shall be presented in a maximum 50-foot grid size and native (*.SHP) files shall be included. The hydrology study shall include an analysis of the following storm events: (a) 10-year, 24-hour; and (b) 100-year, 24-hour.**

4.2.3 **Contractor shall prepare the Turbine Foundation design documents per <u>The Submittal Schedule</u> and containing the following information, at a minimum: (a) design basis; (b) plan and profile view of Turbine Foundation design, including cross sections; (c) details for reinforcing steel, conduit, and grouting; (d) civil works requirements (e.g., backfill, compaction, grading, drainage, etc.); (e) tensioning sequencing and parameters, including post-installation re-tensioning; (f) structural calculations, to be provided with each set of Turbine Foundation design drawings; (g) rebar and embedment ring shop drawings; (h) drawing index; (i) bill of materials; and (j) inspection, testing, and quality control requirements.**

(1) For the avoidance of doubt, the approval of the Turbine Foundation design documents by Owner's independent engineer shall be received *prior* to constructing any portion of the Turbine Foundation. Contractor shall allocate adequate review time to the independent engineer for this purpose and shall coordinate with the independent engineer as reasonably required to address and incorporate any comments required to receive approval.

4.2.4 **Contractor shall provide a foundation inspection report for each Turbine Foundation excavation (each, a "Foundation Inspection Report"). A Foundation Inspection Report, including all accompanying documentation, shall be completed prior to placement of the mud mat and provided to Owner as a condition of each Turbine Foundation completion. Each report shall include information on the foundation excavation, including, but not limited to, (a) date of excavation; (b) date of inspection; (c) ambient air temperature at time of inspection; (d) structure name / number and location; (e) structure type and foundation type; (f) soil conditions; (g) verification of subgrade against expected condition, including test results; and (h) depth to rock and depth to water.**

4.2.5 **Contractor shall prepare concrete mix designs; grout specifications; and concrete and grout placement procedures. All such submittals shall be approved by Owner prior to use. Each mix design submitted by Contractor shall be stamped by a professional engineer with an active license in the state where the Project is located and shall include, at a minimum, (a) documentation of achieving Project-specific compressive strength requirements per ACI procedures; (b) gradation, source, and type of aggregates; (c) mill reports for cement and fly ash; (d) product data for admixtures, including vendor certification of compliance with applicable ASTM standard; (e) ASR test results, including expansion results per ASTM C1567; (f) specified slump value; (g) specified water/cement ratio; (h) specified air entrainment; (i) water quality test per Table 2 of ASTM C1602 if non-potable; and (j) an approval stamp by the applicable engineer of record.**

4.2.6 **Contractor shall submit three (3) laboratory tension test reports for anchor bolts for each heat number furnished, complete with threads, and to be prepared by an independent third-party tester. This task shall be in accordance with ASTM A370 and the report shall include yield stress and tensile stress.**

4.2.7 **Contractor shall provide copies of mill certificates for all steel reinforcement (rebar) and anchor bolts.**

4.2.8 **Contractor shall provide a storm water pollution prevention plan (the "SWPPP") for the Project.**

4.2.9 **If blasting is required, Contractor shall prepare blasting plans and procedures for all blasting work to be performed at the Project Site. All such submittals shall be approved by Owner prior to use.**

4.2.10 **Contractor shall prepare an aggregate mix formula based on recommendations from the final Geotechnical Report and complying with the requirements in Section 4.1.5 herein. Each formula shall be approved by Owner prior to use and shall be accompanied by testing data for each aggregate source, including sieve analysis, moisture data, liquid limit, and plastic limit.**

4.2.11 **Contractor shall submit manufacturer's approval drawings or product sheets (material cut sheets) for all permanently-installed equipment and materials. This shall include, but is not limited to, geotextile fabric, cement stabilization, permanent gates, permanent culverts, block mesh / flexamat (or similar) if used for low-water crossings, anchor bolts, rebar, curing compounds, joint compounds, crack repair compounds, sealants, corrosion inhibitors, and grout.**

4.3 Project Site Preparation

4.3.1 **Contractor shall provide all Project Site preparation as necessary to complete the Work, including, but not limited to, all clearing, grubbing, stripping, grading, compaction, demolition, blasting, excavation, soil stabilization, tree trimming, and drainage.**

(1) Topsoil shall be stockpiled for later use during landscape reclamation activities. Topsoil shall be stockpiled only in areas designated where it will not interfere with construction operations or existing facilities. Stockpiled topsoil shall be reasonably free of subsoil, stumps, roots, debris, and stones larger than three (3) inches in diameter. Topsoil shall not be used as structural fill. Appropriate erosion control measures shall be utilized on stockpiled topsoil.

(2) Root mats and stumps shall be completely removed from the Project Site construction areas; holes refilled with select material and compacted adequately for the ultimate expected loading for the material used; and graded to drain.

(3) Removal of or damage to trees is prohibited without written approval of Owner. Trees shall be adequately protected, including protecting tops, trunks, and roots of existing trees at the Project Site which are to remain.

(4) Any waste generated from such activities, including tree trimmings or grubbed vegetation material, shall be Contractor's responsibility to dispose of.

4.3.2 **Contractor shall provide and maintain throughout the duration of construction activities all necessary construction surveying and marking necessary to construct the Project and complete the Work, to include, but not limited to, (a) grading limits; (b) limits of disturbance; (c) laydown and storage areas; (d) culturally-, archeologically-, and/or environmentally-sensitive areas; (e) utilities, pipelines, and other buried facilities; (f) Wind Turbine locations; (g) access roads and crane paths; (h) Project Substation pads; (i) Collection System Circuit routing; (j) Interconnection Line routing, including centerline and structure locations; (k) O&M Building, including pads, parking area, and property limits; and (l) easements.**

(1) Contractor shall be solely responsible for locating any survey monuments at or near the Project Site and shall replace such monuments if they are disturbed during performance of the Work.

(2) All structure foundations shall be surveyed and staked prior to excavation. The methods of staking and final alignment shall be designed such that the finished condition of the Work meets the requirements for alignment, position, elevation, and rotation.

(3) All permanent Project facilities, including roads, Collection System Circuits (including feeder routing, junction boxes, and splices), and the Interconnection Line (including structures and line routing), shall be surveyed following their construction and included in the applicable As-Built Drawings. Surveyed locations shall be included in the drawings and a Contractor-provided geospatial file (.SHP and/or .KMZ format) for each. Contractor shall also furnish an as-built version of the PLS-CADD (.BAK) file for the Interconnection Line.

4.3.3 **Contractor shall maintain all access roads and construction areas throughout the duration of the Work. Maintenance of such areas shall include washboard removal, pothole removal, snow removal, cleaning of silt and debris from cattleguards, cleaning of silt and debris from culverts as necessary to facilitate drainage, dust control along access roads, and other similar items.**

4.3.4 **Contractor shall furnish, install, and maintain temporary orange snow fencing or other Owner-approved delineation / marking method around all archeologically-, culturally-, and environmentally-sensitive areas at the Project Site, including those identified in the Applicable Permits. All temporary fencing shall be (a) promptly replaced if it becomes deteriorated / unfit for purpose and (b) removed prior to Contractor demobilization but not before Work in the applicable area(s) is completed.**

4.3.5 **Contractor shall excavate and remove all rock as necessary to complete the Work, including any necessary blasting. Contractor shall notify Owner prior to the use of explosives at the Project Site; no blasting shall be performed without explicit written confirmation by Owner.**

(1) When the use of explosives is necessary for the Work, Contractor shall use the utmost care not to endanger life or property and shall comply with all Applicable Laws and other Requirements and conduct the necessary advance notifications. All permits and licenses required for blasting shall be obtained, paid for, and maintained by Contractor.

(2) Owner shall be notified prior to the use of explosives at the Project Site, and such blasting shall be completed, at a minimum, in accordance with the Applicable Permits and Contractor-furnished blasting plan. Blasting shall be performed only by persons who are qualified, competent, and thoroughly experienced in the use of explosives for rock excavation. Blasting near utilities, pipelines, or facilities (buried or above-ground) shall be subject to approval of owning agency and Owner.

(3) Before delivery of any explosives to the Project Site, Contractor shall have obtained a blasting endorsement on their public liability and property damage insurance policy.

(4) All explosives shall be handled in a secure manner, and all such storage places (if permitted) shall be marked clearly "DANGER - EXPLOSIVES" or as otherwise required by law. Under no circumstance shall caps or other exploders or fuses be stored, transported, or kept together with powder.

(5) Blasted material shall be crushed and screened for use as fill on access roads and in other areas of the Project Site assuming the aggregate meets the appropriate geotechnical specifications for this application. Contractor shall be responsible for verifying that the quantity and quality of such rock is suitable for use as aggregate at the Project Site.

(6) Excessive overbreak or damage to adjacent structures, exposed cut slopes, equipment, utilities, or buried pipeline and conduit shall be avoided. Charge holes shall be located properly and drilled to correct depths for charges used, and charges shall be limited in size to the minimum required for reasonable removal of material by excavating equipment. Blast mats shall be utilized as required in sensitive areas, including, but not limited to, archeologically-sensitive areas, environmentally-sensitive areas, existing Project Site facilities, and other Project infrastructure.

(7) Contractor shall not perform any blasting within 500 feet of a pipeline without the pipeline owner's written approval.

4.4 Site Roads

4.4.1 **Contractor shall design, furnish, construct, and install all roads, including access roads and spur roads, temporary turnarounds, intersection/radius improvements, crane paths, and transitions to/from existing roads in conformance with the minimum requirements set forth herein and the [preliminary] design documents in Exhibit [●] (*Design Documents Exhibit Name*). Access roads shall include a road to each Wind Turbine, permanent meteorological tower, Project Substation, O&M Building, at a minimum.**

(1) All roads shall be constructed at the locations shown on Exhibit [●] (*Project Site Plan Exhibit Name*).

(2) Contractor shall furnish all labor, equipment, and materials that are necessary for a complete, fully-functional, and safe roadway configuration.

4.4.2 **Contractor shall furnish and install a gate or cattleguard, pending Owner and Landowner approval, at every location where a roadway penetrates an existing fence line at the Project Site. [NTC: update for what is applicable for Project]**

(1) Each permanent gate shall be a double-hung, prefabricated, finished metal gate; each such gate shall be a minimum 28-feet-wide manual swing gate with a pipe frame and manufacturer's standard coating finish, complete with hinges and latching hardware, and lockable via lag bolt.

(2) Unless explicitly noted otherwise above, all fencing, gates, and cattleguards shall comply with the applicable requirements in Section 4.1.8 herein.

4.4.3 **Contractor shall furnish and install all necessary permanent, barbed wire fencing.**

4.4.4 **Contractor shall furnish and install any necessary matting, blisters, or other similar items required to facilitate crossings of pipelines or other underground facilities during construction, including for Wind Turbine deliveries at the Site.**

4.5 Public Roads

4.5.1 **Contractor shall design, furnish, construct, and install all public road improvements in accordance with the road use agreements in Exhibit [●] (*Road Use Agreement Exhibit Name*), including upgrading and maintaining any public roads, bridges, and culverts as specified therein.**

4.5.2 **Contractor shall maintain graveled public roads within the Site boundary throughout construction of the Project, including dust control, washboard removal, and pothole removal.**

4.5.3 **Contractor shall, prior to mobilization to the Project Site, digitally video and document the condition of existing public roads to quantify the extent of any Contractor-caused wear and tear.**

4.6 Drainage and Erosion Control

4.6.1 **Contractor shall furnish, construct, install, and maintain all temporary and permanent drainage or erosion and sediment control, as necessary to control the erosion of embankments, temporary and final exposed slopes, and temporary stockpiles, and including the use of Best Management Practices (as defined above) all in conformance with the minimum requirements set forth herein, including Section 4.1.6 and the [preliminary] design documents in Exhibit [●] (*Design Documents Exhibit Name*).**

4.6.2 **Contractor shall continuously monitor construction operations to avoid creating conditions that could lead to excessive erosion of soil with surface runoff from Work areas. Contractor shall furnish, construct, and install any necessary controls to protect water quality.**

4.7 Dust Control

4.7.1 **Contractor shall provide construction dust control at the Project Site throughout the duration of the Work, including furnishing of all labor, equipment, and materials, including water and/or palliatives, necessary for dust control and as necessary to reduce the risk of dust becoming a nuisance. Water used for dust control shall be treated to ensure no negative impacts to human health and ecology, including downstream environments; for the avoidance of doubt, potable water is not required for dust control, and treatment of the water source utilized by Contractor for dust control is only required to the extent necessary to comply with the Requirements.**

4.7.2 **Contractor shall provide a one-time application of magnesium chloride to county roads in accordance with Exhibit [●] (*Road Use Agreement*).**

4.8 Turbine Foundations

4.8.1 **Contractor shall design, furnish, construct, and install one (1) Turbine Foundation per Wind Turbine location, including grounding, in conformance with the minimum requirements set forth herein and the [preliminary] design documents in Exhibit [●] (*Design Documents Exhibit Name*).**

(1) Turbine Foundations shall be constructed at the locations shown on Exhibit [●] (*Project Site Plan Exhibit Name*).

(2) Contractor shall furnish all labor, equipment, and materials that are necessary for a complete, fully-functional, and safe Turbine Foundation configuration.

(3) Turbine Foundations shall be conventional spread footing / gravity-type foundations. No alternate Turbine Foundation type, including P&H or rock anchor, shall be utilized without Owner approval.

(4) Turbine Foundations shall be reinforced concrete designed in accordance with Turbine Supplier Project Site Requirements, the Applicable Standards, and the Requirements.

(5) Turbine Foundations shall, at a minimum, be designed using the final Geotechnical Report, including net allowable soil bearing capacity values determined by geotechnical investigation from soil borings at each specific Wind Turbine site and equipment loads provided by Turbine Supplier. No portion of Turbine Foundations shall be constructed on fill material or within ten (10) feet of a fill slope without Owner approval.

(6) Turbine Foundations shall include a grounding grid. The design and construction of the grounding system in such foundations shall meet or include the following requirements, at a minimum: (a) Turbine Supplier Project Site Requirements; (b) incorporate the recommendations, values, and minimum requirements set forth in the Geotechnical Report; (c) installation of adequate ground for personnel safety, including touch and step potentials (to be demonstrated by Contractor via calculations in the grounding study); (d) incorporate local resistivity measurements; and (e) a ground resistance <= 10 ohms.

(7) Turbine Foundation anchor bolts shall have a minimum projection of 12" above tower flange.

(8) Turbine Foundation materials, including rebar, anchor bolts, forms, concrete, and grout, shall comply with the applicable structural requirements in Section 4.1 herein.

(9) The area surrounding the Turbine Foundation shall be constructed with a grade of two percent (2%) sloping away from the Turbine Foundation for the greater of (a) 25 feet from the edge of the pedestal or (b) the distance calculated as 1 foot from the bottom outer edge of the base plus the distance to the surface at a slope of 1H:2V from the bottom of the excavation.

(10) Contractor shall provide all necessary dewatering of the Turbine Foundation excavation.

(11) Turbine Foundation gapping is prohibited without Owner and Turbine Supplier approval.

4.8.2 **Contractor shall furnish and install the subgrade improvements set forth in the Geotechnical Report, including overexcavations, geopiers, and subgrade densification as described therein.**

4.9 Wind Turbine Pads

4.9.1 **Contractor shall design, furnish, construct, and install one (1) Wind Turbine Pad per Wind Turbine location in conformance with the minimum requirements set forth herein and the [preliminary] design documents in Exhibit [●] (*Design Documents Exhibit Name*). Contractor shall maintain the Wind Turbine Pads throughout the duration of the Work.**

(1) Wind Turbine Pads shall be sufficient in size to allow for simultaneous offloading, storage, and assembly of all Wind Turbine components, including, but not limited to, rotor, nacelle, and tower sections.

(2) Wind Turbine Pads shall comply with the Turbine Supplier Project Site Requirements.

(3) Wind Turbine Pads shall be cleared of crops, brush, boulders, and other debris around each Turbine Foundation, up to the pad limits, and shall be continually maintained to ensure a safe working environment.

(4) Wind Turbine Pads shall not exceed two percent (2%) grade, or less if required for the safe execution of Work, including Wind Turbine assembly, storage, or erection.

(5) Wind Turbine Pads shall have a competent, compacted soil working surface with subgrade cleared and compacted to at least ninety-five percent (97%) of the maximum density within the moisture content of two percent (2%) below optimum to two percent (2%) above optimum, as determined by ASTM Standard D698, unless a higher level of compaction is required by the Geotechnical Report or the Turbine Supplier Project Site Requirements.

(6) Crane pads shall be designed and constructed to allow for use of cranes in ongoing Wind Turbine maintenance activities following construction (e.g., cranes required for gearbox removal and / or installation) including preservation of a portion of each crane pad per the requirements in 2.12.3 (3) (a).

4.9.2 **Contractor shall design, furnish, construct, and install a 5/8" crushed stone ring (i.e., "beauty ring") at each Wind Turbine location in conformance with the minimum requirements set forth herein.**

(1) Each beauty ring shall be installed after the applicable Wind Turbine is installed and after the removal (including decompaction) of the Wind Turbine Pad (non-graveled areas) at such location.

(2) Each beauty ring shall be installed around the perimeter of each Wind Turbine location at a minimum distance of twelve (12) feet beyond the Turbine Foundation pedestal wall and Wind Turbine tower stairs in all directions.

(3) Each beauty ring and underlying subgrade (a) shall be shaped to move water away from the Turbine and pad-mount transformer (if any); and (b) shall be constructed to prevent water ponding.

4.10 Testing and Quality Control

4.10.1 **Contractor shall inspect and test each roadway, except for public roads, in accordance with the following minimum requirements. All testing shall be performed by an independent, experienced third party.**

(1) All roadways and compacted areas shall be tested to demonstrate they meet stated design criteria and are fit for purpose.

(2) Testing standards: (a) maximum dry density and optimum moisture content per ASTM D698 or ASTM D1557; (b) in-place density by nuclear methods (shallow) per ASTM D2922; (c) aggregate sampling per ASTM D75; (d) sieve analysis of fine and coarse aggregates per ASTM C136; (e) sand equivalent value per ASTM D2419; and (f) liquid limit, plasticity limit, and plasticity index per ASTM D4318.

(3) Fill material / embankments: (a) proof roll over entire length; (b) grain size analysis, moisture content, Atterberg limits on fines contents, and standard proctor test on each material type; (c) if proof roll fails, moisture density test at 4 per lift or every 1,000 feet of road, whichever is greater; and (d) DCP test at any location where moisture density testing fails. The civil engineer of record shall specify passing criteria for the DCP test (e.g., minimum blows per 6 inches).

(4) Compacted subgrade: (a) proof roll over entire length prior to placement of aggregate base; (b) moisture density test every 1,000 feet or 3 per road, whichever is greater; and (c) DCP test (recorded to a minimum depth of 2 feet) at any location where moisture density testing fails. The civil engineer of record shall specify passing criteria for the DCP test (e.g., minimum blows per 6 inches).

(5) Aggregate base: (a) proof roll over entire length; (b) DCP test (recorded to a minimum depth of 2 feet) every 1,000 feet or minimum 3 per road, whichever is greater; (c) sieve analysis, liquid limit, and plasticity index every 2,500 cubic yards; and (d) Los Angeles abrasion test every 5,000 cubic yards. The civil engineer of record shall specify passing criteria for the DCP test (e.g., minimum blows per 6 inches).

(6) Crane paths (including shoulders): proof roll over entire length.

(7) Other testing set forth in the [preliminary] design documents in Exhibit [●] (*Design Documents Exhibit Name*).

4.10.2 **Contractor shall inspect and test each Turbine Foundation in conformance with the following minimum requirements. All testing shall be performed by an independent, experienced third party.**

(1) All Turbine Foundations shall be tested to demonstrate they meet stated design criteria and are fit for purpose.

(2) Certification of integrity of Turbine Foundation sub-base, including verification that conditions within excavation align with expected / design conditions and all information required in Foundation Inspection Report (as defined herein); *the Foundation Inspection Report, including all accompanying documentation, shall be completed prior to placement of the mud mat*.

(3) Compacted subgrade (all performed prior to placement of mud mat): (a) proof roll over entire length; (b) soil probe or shallow hand auger probes to determine presence of unsuitable soils below the surface, to aid in classifying soils, and to make comparisons of exposed soils to those available in the Geotechnical Report; and (c) static cone penetrometer ("**SCP**") tests on cohesive soils and dynamic cone penetrometer ("**DCP**") tests on cohesionless soils to verify against requirements in the Geotechnical Report, including one test at the center at the Turbine Foundation and one test in each quadrant (five total). The foundation engineer of record shall specify passing criteria for the SCP/DCP test (e.g., minimum blows per 6 inches).

(4) Concrete / grout strength and properties, including break tests, grout cubes, slump, air, and temperature, each at the minimum frequencies specified in Section 4.1.10 and Section 4.1.11 herein.

(5) Random tension test of at least 10 percent (10%) of anchor bolts on each Turbine Foundation. If any bolts do not meet the required tension value, all bolts on such Wind Turbine shall be re-tensioned and the 10-percent check repeated until all tests pass.

(6) Other testing set forth in the [preliminary] design documents in Exhibit [●] (*Design Documents Exhibit Name*) and the recommendations set forth in the Geotechnical Report.

4.10.3 **Contractor shall inspect and test each Wind Turbine Pad (including Turbine Foundation backfill as applicable) in conformance with the following minimum requirements. All testing shall be performed by an independent, experienced third party.**

(1) All Wind Turbine Pads shall be tested to demonstrate they meet stated design criteria and are fit for purpose.

(2) Structural fill below Turbine Foundation: (a) two (2) unit weight tests per lift and (b) two (2) moisture density compaction tests per lift.

(3) Common fill around Wind Turbines / Wind Turbine Pads (including backfill for Turbine Foundations): (a) for every 2,500 cubic yards of fill placed and at least one set per Wind Turbine location, provide (i) grain size analysis per ASTM D422; (ii) moisture content per ASTM D2216; and (iii) standard proctor maximum dry density per ASTM D698; and (b) for each fill lift at each Turbine Foundation backfill location, provide density test per ASTM D6938, including test location, dry density, and moisture content for each test.

(4) All Wind Turbine Pads shall be proof-rolled over the entire area according to the same requirements as Section 4.1.5 (12).

(5) Other testing set forth in the [preliminary] design documents in Exhibit [●] (*Design Documents Exhibit Name*) and the recommendations set forth in the Geotechnical Report.

4.10.4 **Contractor shall notify Owner of all testing schedules at least 30 days in advance of testing activities and copies of testing reports (including a summary of testing procedures and acceptance criteria) shall be submitted to Owner within 10 days of completing such test. Notwithstanding the preceding requirements, a copy of test results for each Turbine Foundation shall be provided to Owner *prior* to erection of the applicable Wind Turbine.**

5.0 COLLECTION SYSTEM CIRCUITS

5.1 General Provisions

5.1.1 ***In addition to anything summarized herein, all Work related to the Project shall conform to Exhibit 7 – MP Electrical Construction Specifications – 35kV Collector System***

5.1.2 **Contractor shall relocate, drop, or cross power lines as needed and as appropriate to complete the Work, with prior approval of the appropriate authority(ies). Contractor shall be responsible for obtaining and maintaining any necessary permits and / or easements for such work.**

5.1.3 **Contractor shall design and construct the Project such that the total annual energy losses under Project Site-specific wind distribution data (to be provided by Owner), measured between the generator leads of each Wind Turbine and the Point of Interconnection shall not exceed 2.0 percent (2.0%) (the "Electrical Loss Limit"). For the avoidance of doubt, this shall include all medium-voltage transformers, Wind Turbine cabling, Collection System Circuit cabling, main step-up transformer, and the Interconnection Line up to the Point of Interconnection.**

5.1.4 **Contractor shall design and construct the Collection System Circuits in accordance with the Collection System Electrical Studies, as defined herein.**

5.1.5 **All Collection System Circuits shall be installed underground.**

5.1.6 **No more than 15 Wind Turbines or 35 megawatts of combined capacity shall be installed on any single Collection System Circuit.**

5.1.7 **Access to the Collection System Circuits shall be from existing roads or new access roads within the permitted area. Exact Collection System Circuit routing shall be determined, however, the preferred routing shall be to parallel the access roads and crane paths as much as possible, so long as such routing does not increase the required number of crane breakdowns. When not practical or efficient to parallel the access roads, the Collection System Circuit shall be routed in a straight line, shortest distance as much as possible.**

5.1.8 **All Collection System Circuit backfill, including splice pits (if used), shall be compacted to a minimum of 85 percent (85%) of standard proctor density, unless otherwise noted on the design drawings. For the avoidance of doubt, collection backfill at Turbine Foundations and access road crossings shall be compacted to ninety-five percent (95%) as noted elsewhere herein.**

5.1.9 **Requirements for power cabling:**

(1) All Collection System Circuit power cabling shall be 34.5-kV, three (3)-phase, 60 Hertz.

(2) Jacketed, single-conductor, appropriately-sized concentric neutral, insulated medium-voltage underground distribution power cable shall be used. All underground Collection System Circuit power cabling shall be supplied with a minimum of 100 percent (100%) insulation that meets or exceeds all requirements of applicable AEIC, IEEE, ICEA, NEMA, and UL standards. All Collection System Circuit cables shall be UL listed.

(3) Collection System Circuits shall be of a discharge-free design and suitable for direct burial, installation in duct and exposure to sunlight on an alternating current, three-phase, 34.5-kV nominal, 60-Hertz power system.

(4) All central conductors shall be Class B stranded. No more than one (1) conductor per cable shall be allowed. Conductor material shall be aluminum or copper. Allowable conductor sizes are 1/0 AWG through 1500 kcmil.

(5) Cable ampacity shall not exceed 95 percent of the rated value, based on Project Site-specific thermal resistivity and in consideration of all external heat sources. Ampacity shall be calculated assuming the soil around the cable within the trench is dried out to zero percent (0%) moisture content and that soil above the cable within the trench is at two percent (2%) moisture content.

(6) Notwithstanding the requirements for cable crossings in Section 5.1.11 herein, all underground Collection System Circuit cabling shall be direct buried at a depth of at least 42 inches below grade.

(7) A sufficient amount of cable slack shall be provided to allow installation of elbows and termination of the cables to the appropriate junction box and/or Wind Turbine switchgear terminal and permit ready disconnection of the elbows and mounting on the parking stands. For the avoidance of doubt, such slack shall allow for the installation / service disconnection of connectors, dead breaks, and other similar devices.

(8) Excess slack shall be provided to allow re-termination in the event of failure. The excess slack at each Wind Turbine location shall be in the form of a maintenance loop. At least 25 feet of excess cable shall be provided at each Wind Turbine such that the cables may be re-terminated if needed following installation.

(9) All Collection System Circuit power cabling shall be provided with terminators and labels. Labels shall be permanently attached at both ends. Labels shall be sequentially numbered.

(10) Collection System Circuits shall be designed to minimize the use of cable splices. Underground splices, if used, shall be identified using GPS-located marker balls, and splices shall only be performed by a skilled, qualified craft worker who shall receive training at the Project Site from the splice kit manufacturer prior to performing splices; the coordinates of each splice shall be recorded and noted within the As-Built Drawings. Splicing of different cable types, splices between Wind Turbines (except at directional boring locations), and "dutchman" cable splices are each strictly prohibited.

(11) Excessive bending of cabling shall be avoided, and the manufacturer recommended bending radius shall not be exceeded.

(12) BIL voltage rating: 200 kV.

(13) Maximum short-circuit conductor temperature: 250°C.

(14) Only Turbines from the same manufacturer shall be installed on a circuit (e.g., all Siemens Gamesa Turbines shall be on the same circuit(s) and all GE Turbines shall be on the same circuit(s); no GE Turbines shall be on a Siemens Gamesa circuit or vice versa).

5.1.10 **Requirements for trenches:**

(1) All Collection System Circuits shall be installed via trenching; plowing is not permitted and excavation by blasting for the Collection System Circuits is strictly prohibited. Trench widths shall be kept to a minimum to allow sufficient space for equipment installation. The trench bottom shall be firm for the entire length and width. Trenches shall be kept free from water. Conduit and cable shall not be placed on frozen ground.

(2) Bedding and/or backfill material shall be installed around all buried Collection System Circuits to provide physical and/or thermal protection for buried cable. All trench bedding and/or backfill materials shall be screened and visually inspected for materials in excess of two (2) inches, with any backfill within 12 inches of cable being free of sharp objects, rocks, and other debris larger than 0.5 inches. All bedding and/or backfill material shall be composed of materials that are native to the Project Site. Such materials shall be free of debris, roots, organic matter, frozen matter, coal, ashes or cinders.

(3) In all areas, collect rocks, defined as four (4) inches in diameter or larger, unearthed during excavation as part of the Work and separated using a rock bucket, but not utilized in the construction of the Project and store at Owner-approved locations.

5.1.11 **Requirements for cable crossings:**

(1) All Collection System Circuit (a) railroad crossings shall be buried at a depth of at least 120 inches below the railroad; (b) public road crossings shall be buried at a depth of at least 60 inches below the road, including the ditch(es) on either side; (c) wetland and stream crossings shall be buried at a depth of at least 60 inches below the steam bottom; and (d) utility and pipeline crossings shall be buried at a depth of at least 48 inches below the existing utility or pipeline. All other Collection System Circuit crossings shall be buried at a depth of at least 48 inches below the applicable infrastructure.

(2) All Collection System Circuit crossings shall be installed in conduit as more particularly described in Section 5.1.19 below.

(3) All crossings, including public road, railroad, pipeline, utility crossings, property lines, wetlands, and streams, shall be marked on each side with buried marker balls and above-ground cable markers, each meeting the requirements in Section 5.1.12 below.

(4) Contractor shall coordinate with local utilities and pipeline companies as set forth in Section 2.11.3 herein.

5.1.12 **Requirements for markers:**

(1) Cable marking tape shall be furnished and installed in all trenches. Such tape shall be red, metallic, and detectable. Marking tape shall be placed 12 to 18 inches above cable.

(2) GPS-located marker balls shall be placed within all cable trench at the following: (a) each side of crossings / directional bore locations; (b) each above-ground cable marker location; (c) every splice location; and (d) all 90-degree turns in a Collection System Circuit.

(3) Above-ground cable markers shall be a Curv-Flex marker or equivalent and shall include a decal warning of buried cable and other Owner-approved details.

5.1.13 **Requirements for fiber optic cabling:**

(1) Fiber optic cable shall be installed in the same trench as the Collection System Circuit power cabling.

(2) When fiber cables are installed in a trench, the fiber cable shall be placed in conduit or continuous innerduct; the fiber cable shall be rated for underground use; and there shall be a suitable locating cable installed in the innerduct/conduit. Innerduct shall have a minimum diameter of 1.25 inches. Fiber optic shall be separated from any power cables when co-located in a trench.

(3) Fiber optic cable shall be as shown below, or other Owner-approved cable:

Type	AFL spec #	Fiber Count	Outside diameter (inches)	Weight (lbs/ft)
AC02496521BB0	DNA-32168	24	0.505	0.093
AC0489C521BA1	DNA-32593	48	0.51	0.093
AC0969O621BA2	DNA-32595	96	0.575	0.122

(4) All fiber cables shall consist of a minimum of 12-strand single mode fiber, except that the fiber run between the Project Substation and O&M Building shall be a minimum of 48-strand. All fiber runs shall be required to maintain a minimum of at least one (1) gigabyte bandwidth throughout the backbone of the system.

(5) Reserved.

(6) All fiber cables shall be designed with a minimum of fifty percent (50%) spare fiber.

(7) Excess slack shall be provided to allow re-termination in the event of failure. At least 60 feet of excess cable shall be provided at each pull box such that the cables may be re-terminated if needed following installation. Terminations shall be completed with either an approved fiber optic pigtail kit or with approved mechanical connectors and an approved fanout kit.

(8) All communications cables, including fiber cables, shall be appropriately labeled with a permanently-attached label at both ends. Labels shall be sequentially numbered.

(9) The fiber system shall be designed for a minimum of five (5) dB system margin.

(10) The fiber system design shall be a fiber ring topology or a "daisy-chained" system.

(11) Conduits for fiber entry into the Wind Turbine areas shall include a pull string for pulling the cable.

(12) Fiber cables may be routed through Project Substation control cable trenches with other control wiring provided that a high-visibility color innerduct is used for identification and protection of the fiber cables.

(13) All splices shall be fusion splices. Other types of splices are subject to Owner approval.

(14) Maximum attenuation: (a) 0.35 dB/km at 1310 nm and (b) 0.25 dB/km at 1550 nm.

(15) Data collection loops shall be designed so that a loss of a power circuit does not cause a loss of data collection from the Turbines during the power outage.

5.1.14 **Requirements for junction boxes:**

(1) Junction boxes shall meet the requirements of ANSI C57.12.28, including water resistance.

(2) Junction boxes shall be stainless steel or fiberglass.

(3) Junction boxes shall be lockable with a padlock.

(4) Junctions boxes shall be installed level and plumb, and set on concrete with a rock base, with excavations filled with a minimum 2,000 psi slurry.

(5) Junction boxes shall be clearly marked with an appropriate high-voltage sign identifying the junction box number and Collection System Circuit number.

(6) The coordinates of each junction box shall be recorded and noted within the As-Built Drawings. Junction box locations shall be installed reasonably close to a roadway or Wind Turbine location to facilitate access. All junction box locations are subject to Owner approval.

(7) No medium-voltage cable run shall exceed 10,000 feet without a sectionalizing junction box.

(8) A flag shall be installed at each junction box location to make them visible in the event of high snow or crops.

5.1.15 **Requirements for pad-mount transformers:**

(1) If not supplied internal to the Wind Turbine, each Wind Turbine location shall include a medium-voltage, pad-mount transformer. Such transformer shall be sufficiently sized to allow the full Wind Turbine capacity to be delivered. Pad-mount transformers (including spares) shall be in accordance with the requirements set forth in Table 1 (*Summary of General Requirements for Pad-Mount Transformers*) herein, at a minimum.

Table 1: Summary of General Requirements for Pad-Mount Transformers

Description	Value
Quantity	1 per Wind Turbine plus spares noted herein
Type	Oil filled, hermetically sealed, outdoor installation
Voltage ratio	34,500 / 690 Volts [NTC: update based on Wind Turbine model]
Phases	3
Windings	2 (MV, LV)
Steady state temperature rise	65°C above ambient
Frequency	60 Hz
Impulse levels	150 kV (General), 200 kV (Windings)
Vector group	Grounded wye/delta
Cooling	ONAN
Tapping range	±5%, 2.5% steps, manual control
Paint finish	Munsell Green
Guaranteed losses	Not used (see Electrical Loss Limit)
Temperature gauge	Required
Pressure level indicator	Required
Pressure relief device	Required
Oil sampling valve	Required (located on end of drain valve inside LV compartment)
Filling orifice	Required
Tank ground tag	Required
Oil level indicator	Required
Grounding	Solid (MV source, LV winding), un-grounded delta (MV winding)

(2) Pad-mount transformers shall be fitted with in-line, medium-voltage rated, current-limiting fuse protection per phase utilizing suitably-rated, oil-immersed, current-limiting fuses. The selection of these fuses shall be such as to ensure (a) compliance with the requirements of IEC 60787 or ANSI/IEEE equivalent; (b) short circuit protection of the MV transformer winding; (c) that degradation of the fuses does not occur as a result of the flow of repeated transformer magnetizing in-rush currents; and (d) ease of replacement following an in-service operation.

(3) Pad-mount transformers shall be fitted with a low-side disconnect with means to take a Wind Turbine offline without taking an entire Collection System Circuit offline.

(4) Enclosure:

(a) The pad-mount transformer shall include a fully-enclosed, transformer mounted, MV and LV termination, steel cabinet, suitable for outdoor installation, as per ANSI C57.12.28. The cabinet must be so designed as to fully enclose all cable tails, cable terminations, grounding tags and transformer fittings within a tamper and rodent resistant, secure enclosure.

(b) The cabinet shall extend to floor level, fully shrouding all cable tails, having the facility for being directly bolted to the supporting pad. The cabinet depth shall be at least 24 inches.

(c) The MV and LV compartments shall be partitioned such that access to each compartment is via a separate door. External access shall be available through the LV compartment door only, with access to the MV compartment door lock being available within the LV compartment. The doors shall be fitted with an all steel, robust, tamper proof, three point (i.e., top, mid, and bottom) integral locking system. Each door shall have the facility of being securely locked shut via the application of a dedicated pad lock.

(d) The transformer name plate and all transformer indication fittings (e.g., oil level indicator, oil temperature indicator) shall be located within the LV compartment, while all transformer operational fittings (e.g., tap changer switch, isolation switch etc.) shall be located within the MV compartment.

(e) The cabinet doors shall be fitted with anti-close stays designed such that both doors can be held open at right angles. The anti-close stay design shall be sufficiently strong enough to withstand the prevailing wind conditions.

(5) Foundations / vaults:

(a) Pad-mount transformers shall be installed with a fiberglass or concrete box pad.

(b) Box pads shall be installed level and plumb, and set on concrete with a rock base. Excavations shall be filled with a minimum 2,000 psi slurry mix.

5.1.16 **Requirements for surge arresters:**

(1) Surge arresters shall be provided at the end of each string of Wind Turbines. Surge arresters shall be 35-kV class, 600A, 30kV/24.4kV MCOV (or greater if required by the Contractor-provided TOV study) equipment meeting the requirements of ANSI C62.11 for Station Class installation in a 60-Hertz outdoor installation, unless a greater rating is required by the Contractor-provided transient overvoltage study.

(2) Surge arresters shall provide overvoltage system protection in an insulated, fully shielded, submersible, dead-front device. Surge arresters shall be provided in pre-molded rubber elbows.

5.1.17 **Requirements for grounding:**

(1) Grounding connections at junction boxes and pad-mount transformers (if any) shall be bolted to facilitate separation of grounds for continuity testing and ground mat testing.

(2) Ground rods shall be incorporated into the grounding system (a) if determined to be necessary by the results of the Contractor-provided grounding study and/or (b) if required by Turbine Supplier. Ground rods shall be copper-clad, 5/8-inch diameter, 10-foot-long rods at a minimum.

(3) Turbine Foundations shall include a grounding grid, as further described herein.

(4) Meteorological towers shall be independently grounded; meteorological tower grounding shall not be interconnected to the Wind Turbine grounding system.

(5) All below-grade grounding connections shall be exothermic weld (e.g., Cadweld); mechanical / compression connections are not permitted.

5.1.18 **Requirements for bollards:**

(1) Bollards shall (a) be a minimum three (3)-inch diameter steel pipe or a minimum four (4)-inch diameter schedule 40 PVC; (b) be concrete filled for equipment protection (minimum 2,000 psi); (c) be painted safety yellow; (d) extend four (4) feet above grade with at least six (6) inches below the bollard for concrete; and (e) tie into the Wind Turbine ground grid.

5.1.19 **Requirements for conduit:**

(1) All above-ground power and communications cabling shall be installed in conduit. All below grade crossings, including public road and utility crossings, shall be installed in conduit. Conduit shall be installed from each Wind Turbine to each pad-mount transformer.

(2) Conduit size / fill ratio shall be in accordance with ANSI / NFPA 70, at a minimum.

(3) The location of all conduit shall be recorded within the As-Built Drawings.

(4) Non-metallic conduit shall be protected from sunlight.

(5) The interior surface of all conduits shall be smooth to prevent damage to the cables. When cable is pulled into a duct, a suitable pulling lubricant shall be used and bell housing shall be installed on all conduit ends.

(6) HDPE conduit shall be SDR13.5 or heavier if needed to avoid damage when pulling into the bored hole. HDPE shall be one continuous length or connected together with fused joints.

(7) Use suitable temporary plugs or caps to protect installed conduit against entrance of dirt, moisture, and debris.

(8) All conduit materials required shall be furnished new and undamaged in accordance with the following requirements, at a minimum:

(a) Duct: polyvinyl chloride, Schedule 40 PVC in accordance with NEMA TC-2.

(b) Couplings: plastic, for use with duct previously specified and “Duct-to-steel” adapters as required, including joint cement.

(c) Spacers: plastic high impact, interlocking, base and intermediate type

(d) Factory bends and sweeps: Schedule 40 PVC, 3-foot minimum radius (or greater if required to not violate the minimum bending radius of the cable being installed in it).

(e) End bells: plastic.

(f) Plugs: plastic, high impact, tapered to fit end bell provided.

(g) Duct binder: hemp or sisal twine coupling.

5.1.20 **Requirements for miscellaneous material:**

(1) Cable accessories, terminators, dead front, load break and/or dead break elbows shall be designed and manufactured for the cable to be utilized and rated 600-amp for outdoor 34.5-kV use.

(2) Dead front, load break, and/or dead break elbows shall be supplied with test ports.

(3) Cable fault indicators shall be installed. The remote head shall be mounted in the cabinet wall to allow viewing from outside the cabinet. Directional fault indicators shall be installed at every junction box and at a frequency of no more than every third Wind Turbine location (i.e., such that any single fault indicator monitors no more than three (3) cable segments).

5.2 Submittals

5.2.1 **Contractor shall prepare the Collection System Circuit design documents per The Submittal Schedule and containing the following information, at a minimum: (a) design basis; (b) plan view of the overall system, including power and fiber; (c) one-line electrical diagram; (d) fiber optic loop diagram, including communication loop and connection / termination details for all Wind Turbines, permanent meteorological towers, and the O&M Building; (e) cable installation details, including cable specifications, trench details, splice details, and cable marker details; (f) cable crossing details and schedule, including road crossings, utility crossings, pipeline crossings, and directional boring; (g) grounding details, including trench grounds and Wind Turbine grounding; (h) termination details, including junction boxes and Wind Turbine switchgear; (i) junction box details; (j) meteorological tower power details; (k) conduit and cable schedules; (l) civil works requirements (e.g., backfill, compaction, grading, drainage, etc.); (m) drawing index; (n) bill of materials; (o) inspection, testing, and quality control requirements; and (p) geospatial file (.SHP and/or .KMZ format) showing all Wind Turbines, cable routing, and junction box locations, at a minimum.**

5.2.2 **Contractor shall prepare equipment specifications to define the requirements and properties for the procurement of all permanently installed Collection System Circuit equipment and materials. The specifications shall be submitted to Owner for review *prior* to the procurement of the applicable equipment. The following specifications shall be provided, each as applicable to the design: (a) construction specification; (b) pad-mounted transformers, including vaults; (c) junction boxes; (d) power cable; (e) fiber optic cable; (f) handholes / enclosures; and (g) surge arresters.**

5.2.3 **Contractor shall submit manufacturer's approval drawings or product sheets (material cut sheets) for all permanently installed Collection System Circuit equipment and materials, including all items identified in Section 5.2.2 above as well as splice kits, marker balls, fault detectors, surge arresters, patch panels, and elbows.**

5.2.4 **Contractor shall prepare a set of studies and analyses for the Project (collectively, the "Collection System Electrical Studies") to demonstrate the adequacy of the proposed electrical system design, including any studies and analyses that may be necessary to ensure compliance with the Requirements, including the Applicable Standards or utility requirements. The Collection System Electrical Studies shall be submitted to Owner for review *prior* to the procurement of the applicable Equipment. The following shall be included in the Collection System Electrical Studies, at a minimum:**

(1) Cable Ampacity Study: load flow study with power flow analysis for the Collection System Circuits, including all medium-voltage cable and low-voltage cable (from the Wind Turbine to the pad-mounted transformer) [if any]. Final report shall include a table showing cable ampacity and percent loading per cable section corresponding to the Project one-line diagram. Cable ampacity shall not exceed the limit set forth in Section 5.1.9(5). All external heat sources shall be considered, including parallel circuits. Thermal design shall account for actual field soil samples and backfill requirements (native or engineered).

(2) Short Circuit Study: short circuit analysis of Collection System Circuits, Project Substation, and Interconnection Line, including secondary values on Wind Turbines. The short circuit analysis and study shall be utilized in Contractor's electrical designs to support relay coordination study and equipment specification.

(3) Annual Energy Loss Report: electrical losses evaluation, including estimate of annual energy losses for Project design. Such analysis shall be sufficient to demonstrate that the Electrical Loss Limit, as defined herein, is not being exceeded, and shall be based upon Project-specific cabling and transformer specifications, Project Site-specific soil conditions, Project Site-specific wind data, and other similar considerations. A pre-construction annual energy loss report and an as-built energy loss report, respectively, shall be submitted.

(4) Reactive Compensation Study: reactive power flow report, including power factor study at Point of Interconnection. The study shall identify reactive compensation required to meet the Requirements, including the Generator Interconnection Agreement requirements for power factor and voltage regulation, and including any capacitor bank and/or reactor requirements. The study shall include combinations of (a) active power (no load to full load at ten percent (10%) increments); (b) power factor (0.95 leading to 0.95 lagging); and (c) voltage (0.95 to 1.05 pu) at the Point of Interconnection, or more stringent as necessary to meet the Requirements, including the Generator Interconnection Agreement and compliance with FERC Order 827.

(5) Harmonic Analysis Report: power quality analysis at the Point of Interconnection to determine the harmonic resonance and flicker conditions within the Project, and demonstration that the Project design meets the harmonics distortion requirements in the Requirements (including IEEE 519), including any necessary filtering or mitigation. A pre-construction harmonic analysis report (performed at 90 percent design) and an as-built harmonic analysis report, respectively, shall be submitted.

(6) Harmonics Metering Plan: process to measure the harmonic voltage distortion and harmonic current distortion at the Project to compare with the limits of IEEE 519-2014. The plan shall include recommendations for harmonic metering equipment, equipment locations, and measured quantities where the resulting harmonic meter dataset collected will be used to determine whether there are any harmonics at the site which might damage equipment or be cause for concern.

(7) Concentric Induced Voltage Report: analysis to calculate the maximum induced voltage on the Collection System Circuit shield wires.

(8) Insulation Coordination Report: study to ensure the insulation coordination requirements of IEEE C62.22-2009 have been satisfied within the Project electrical design, including proper application of surge arresters to safeguard electric power equipment within the Collection System Circuits, Project Substation, and Interconnection Line against hazards of abnormally-high voltage surges of various origins.

(9) Transient Overvoltage Report: study to confirm any system modifications required to adequately limit transient overvoltage on the Collection System Circuits, including determination of the transient overvoltage levels on the Collection System Circuits after feeders have been isolated from the Project Substation due to a line-to-ground fault, and determination of the maximum energy required to be absorbed by each surge arrester on the Collection System Circuit feeders.

(10) Wind Turbine Ground Grid Report: analysis of Wind Turbine grounding design to verify the adequacy of the proposed design and the safety of personnel working in or around the Wind Turbine. The study shall confirm that the grounding system maintains touch and step voltages within tolerable limits, and shall be prepared in accordance with the procedures, data, and recommendations given in IEEE 80). The study shall determine the ground potential rise with respect to remote earth, and Turbine Foundations shall be modeled as they are actually constructed (i.e., if not solidly bonded (e.g., using wire ties), they should be modeled accordingly). The study shall consider clearing time in the event of a breaker failure for the purpose of determining if the grounding design (e.g., ground potential rise) is acceptable.

(11) Arc Flash Study: see Section 6.2.4(10).

5.2.5 **Contractor shall prepare energization plans and procedures for each Collection System Circuit. Energization plans shall be submitted to Owner for at least 60 days in advance of the planned Energization date. Energization plans shall include both electrical and communications infrastructure as well as backfeed plans, soaking plans, testing plans, and lock out tag out procedures, at a minimum.**

5.2.6 **Contractor shall provide a complete recommended spare parts list for the Project's electrical works, including the Collection System Circuits. Such list shall include recommended quantities, part / model numbers, and nominal pricing.**

5.3 Collection Circuits

5.3.1 **Contractor shall design, furnish, construct, and install the Collection System Circuits in conformance with the minimum requirements set forth herein and the [preliminary] design documents in Exhibit [●] (*Design Documents Exhibit Name*).**

(1) The Collection System Circuits shall be installed at the locations shown on Exhibit [●] (*Project Site Plan Exhibit Name*).

(2) The Collection System Circuits shall not cross through (under / over) the O&M Building yard.

(3) Contractor shall furnish all labor, equipment, and materials that are necessary for a complete, fully-functional, and safe Collection System Circuit configuration.

5.3.2 **Contractor shall furnish a quantity of [QUANTITY] medium-voltage, pad-mounted transformers, including one (1) per Wind Turbine location plus three (3) spare unit per Wind Turbine type. All spare units shall be specifically marked and packed for storage.**

5.3.3 **Contractor shall complete all electrical connections of the Wind Turbines to the Collection System Circuits, as more particularly described in Section 10.4.3 herein.**

5.3.4 **Notwithstanding the following sentence and as more particularly described in Section 10.4.3 herein, Contractor shall complete all fiber optic terminations, including, but not limited to, those at the O&M Building, Project Substation, and permanent meteorological towers. Turbine Supplier shall complete all fiber optic terminations in the base of each Turbine.**

5.3.5 **Contractor shall perform directional boring at all Collection System Circuit crossings with a stream, wetland, public road, railroad, pipeline, or other buried facility; refer to Section 5.1.11 herein for crossing requirements.**

5.3.6 **Contractor shall install four (4) bollards around every junction box and pad-mount transformer, respectively.**

5.3.7 **Collection System Circuits shall be designed and constructed such that any single Wind Turbine can be de-energized at the 34.5 kV level, without affecting other Wind Turbines on the circuit. This shall be done with load-break switches integrated into the 34.5 kV/690 V transformers or standalone 3-way or 4-way switches.**

5.4 Testing and Quality Control

5.4.1 **Contractor shall test, commission, start-up, and place into successful operation each Collection System Circuit, including the electrical infrastructure and communications infrastructure. At a minimum, testing shall be in conformance with the following minimum requirements. All testing shall be performed by an independent, experienced third party.**

(1) All Collection System Circuits shall be tested to demonstrate they meet stated design criteria and are fit for purpose.

(2) All testing specified in the Applicable Standards, including NETA.

(3) All testing reasonably recommended or required by the applicable equipment suppliers.

(4) All exposed cable sections (including Turbine cabling) shall be visually inspected for physical damage or manufacturing defects. Such inspections shall be performed prior to and during installation.

(5) Resistance testing on grounding grid at each Wind Turbine location and junction box.

(6) Megger test of all 34.5-kV Wind Turbine cables.

(7) Very low frequency ("**VLF**") test of all 34.5-kV power cabling *prior* to energizing. Testing shall be performed at 0.1 Hertz for at least 60 minutes and in accordance with IEEE 400.2. Testing shall include all terminations and splices.

(8) Insulation resistance testing of all low-voltage cabling, including Wind Turbine down-tower cabling and 600-Volt class meteorological tower cabling.

(9) Final continuity tests (including phase continuity of each phase) after completion of all system connections.

(10) Partial discharge testing on each [splice / Collection System Circuit homerun / Collection System Circuit / Collection System Circuit cable of size [TBD] kcmil or larger]. All partial discharge testing shall be performed at a minimum of 200 percent of the rated voltage of the cable and at 60 Hertz. All partial discharge testing shall be performed following installation of the cabling, including backfill, but prior to energization. VLF testing shall not be performed on the same cable segments where partial discharge testing was performed.

(11) Compaction testing shall be verified at a minimum of every 1,000 feet and at every splice pit location. Compaction testing shall be performed at depths of approximately 12 inches and 24 inches, respectively, below grade.

(12) Communications system testing per Section 8.4 herein.

(13) Pad-mount transformers, minimum factory testing on all units unless expressly noted otherwise: (a) all tests identified as "Routine" in IEEE C57.12.00 Table 18 and performed in accordance with IEEE C57.12.90.00; (b) resistance measurements of all windings; (c) polarity and phase relation; (d) ratio at rated voltage on all taps; (e) no-load losses and excitation current; (f) load losses and impedance voltage; (g) lightning impulse test on first unit produced; (h) audible sound emissions on first unit produced; (i) dissolved gas analysis on all units *prior* to temperature rise test; (j) temperature rise test on first unit produced; (k) dissolved gas analysis on tested unit *after* temperature rise test; (l) dielectric tests; (m) oil testing on all units *prior* to energization; and (n) oil testing on all units within 30 days of energization.

(14) Other testing set forth in the [preliminary] design documents in Exhibit [●] (*Design Documents Exhibit Name*).

5.4.2 **Contractor shall notify Owner of all testing schedules at least 30 days in advance of testing activities and copies of testing reports (including a summary of testing procedures and acceptance criteria) shall be submitted to Owner within 10 days of completing such test.**

6.0 PROJECT SUBSTATION

6.1 General Provisions

6.1.1 ***In addition to items herein, all Work related to the Project shall conform to Exhibit 8 – MP Substation Specifications and Exhibit 9 – MP Control Standards and Specifications; for the avoidance of doubt, in the event of conflicting specifications, Exhibits 8 and 9 shall take precedence.***

6.1.2 **The Project Substation shall be designed and constructed to withstand a 100-year, 24-hour storm event. Final constructed grade shall be at least six (6) inches above such flood depth, as determined in the Contractor-provided hydrology study.**

6.1.3 **The Project Substation shall be designed and constructed to a high level of reliability and shall meet or exceed the requirements set forth by the interconnection utility.**

6.1.4 **Contractor shall design and construct the Project Substation in accordance with the Project Substation Electrical Studies and the Electrical Loss Limit, each as defined herein.**

6.1.5 **Project Substation basic impulse level shall be at least 200 kV for the 34.5-kV system and subject to Owner approval on the high-voltage system (to be determined based on the Project voltage level). Design of the high-voltage and 34.5-kV systems shall be for a short circuit rating calculated based on the results of a Contractor-furnished short circuit study.**

6.1.6 **Notwithstanding the immediately following sentence, no splices shall be made within the Project Substation, including both power and instrument and control conductors. Shields may be spliced where necessary to permit connection to the Project Substation ground system.**

6.1.7 **Reserved.**

6.1.8 **Project Substation equipment paint shall be ultraviolet resistant. The coating shall consist of rust-inhibiting epoxy primer, standard intermediate coating, and two (2) finish coats of paint. The total coating shall be a minimum of five (5) mils dry. The paint color of all equipment shall match.**

6.1.9 **The Project Substation shall be designed and constructed to meet guidelines set forth by the Avian Power Line Interaction Committee ("APLIC"), including both the medium-voltage and high-voltage sides of the Project Substation.**

6.1.10 **Requirements for Project Substation civil and structural works:**

(1) All civil works for the Project Substation shall comply with the applicable specifications in Section 4.0 *(Civil / Structural Works*) and Exhibit 8 (*MP Substation Specifications*). In the event of conflicting information between the minimum requirements set forth herein and Exhibit 8 (*MP Substation Specifications*), the Owner Specifications shall prevail.

(2) All Project Substation structures, foundations, assemblies, and components shall be designed and constructed in accordance with the applicable structural works specifications in Section 4.1.

(3) Excavation by blasting for the Project Substation is prohibited.

(4) Trench widths shall be kept to a minimum to allow sufficient space for equipment installation. The trench bottom shall be firm for the entire length and width. Trenches shall be kept free from water. Conduit and cable shall not be placed on frozen ground.

(5) Project Substation equipment shall have wind and seismic withstand capability in accordance with the Applicable Standards, including IEEE 693 and AISC's "*Manual of Steel Construction*".

(6) Areas at the Project Substation to be surfaced with finish rock, including areas outside the permanent fence, shall be treated with a weed eradicator and soil fumigant. Care shall be taken with the application of the soil sterilant to prevent contamination of adjacent areas.

6.1.11 **Requirements for substation cabling:**

6.1.12 **Refer to Owner standards, see Exhibit TBD (*MP Substation Specifications*).**

6.1.13 **Requirements for substation bollards:**

(1) See Section 5.1.18 herein.

(2) Non-metallic bollards shall be placed as appropriate around the perimeter of above-grade equipment (including trenway as needed), in areas within or adjacent to driving lanes.

6.1.14 **Requirements for main power transformer:**

6.1.15 **Refer to Owner standards, see Exhibit TBD (*MP Substation Specifications*). Contractor Requirements for circuit breakers:**

(1) Refer to Owner standards, see Exhibit TBD (*MP Substation Specifications*).

6.1.16 **Requirements for disconnect switches:**

(1) Refer to Owner standards, see Exhibit 8 (*MP Substation Specifications*).

6.1.17 **Requirements for grounding transformers: not used**

6.1.18 **Requirements for reactive compensation devices:**

(1) Reactive compensation devices, including capacitor banks and/or reactors, shall be sized and incorporated into the Project electrical design to comply with the Requirements, including the Interconnection Agreement and FERC Order 827. Sizing of each device shall comply with the Contractor-prepared Reactive Compensation Study described herein.

(2) For additional capacitor bank requirements, refer to Owner standards, see Exhibit 8 (*MP Substation Specifications*).

(3) Reactors shall be no greater than 5 MVAr per stage / step. Care shall be taken to minimize induced coupling currents into structures and adjacent equipment.

6.1.19 **Requirements for space heaters:**

(1) Breakers and other outdoor equipment shall be furnished with space heaters (if not already provided by manufacturer of the equipment) that are thermostatically controlled and shall be rated single phase 240V for operation on 120V and shall include personnel protection screens.

6.1.20 **Requirements for surge arresters:**

6.1.21 **Refer to Owner standards, see Exhibit 8 (*MP Substation Specifications*). Requirements for rigid bus:**

6.1.22 **Refer to Owner standards, see Exhibit 8 (*MP Substation Specifications*). Contractor Requirements for connectors and fittings:**

(1) Connectors and fittings shall be of the proper size and design to assure permanent, secure, and low-resistance connections.

(2) Rigid bus connections to transformers, breakers, CCVTs, or freestanding current transformers are prohibited.

(3) For electrical pad connections, stainless steel hex-bolts, hex-nuts, flat washers, and Belleville washers shall be provided. Belleville washers shall have a minimum compression rating of 4,000 pounds. Bolt lengths shall be sized to provide minimal projection beyond hex nut to prevent excessive noise due to corona, but entire hex nut must be engaged.

(4) For copper to aluminum connections, shall utilize tinned fittings or a transition pad to negate the effects of galvanic corrosion.

(5) All connections between stranded aluminum or ACSR-type conductors and equipment stud terminals shall be made with a stud-to-pad type stud connector and a compression or swage type cable-to-pad type conductor termination.

(6) All dead-end fittings, terminals, splices, and other similar items for ACSR and other types of stranded aluminum conductor shall be tubular compression or swage type fittings. In no case shall any type of stranded aluminum conductors be used with bolted or clamp-type fittings, except for through-type connections to surge arresters on transformers. At least five percent (5%) extra dead-end body filler plugs for each type used shall be provided.

(7) Stranded and tubular copper bus work, where used, shall have connectors and fittings with a minimum of four (4) bolts or two (2) "U"-bolts on each side of each joint.

(8) Fittings shall develop the full strength of the conductor and shall be capable of carrying the full current capacity of the conductor.

(9) Fittings for shield wire dead ends, splices, and taps shall conform to the following:

   (a) Shield wire dead-end fittings shall be compression type with bolted jumper connection. Shield wire insulators shall be located as indicated.

   (b) Compression sleeves for shield wire tension splices shall be used which will develop at least ninety percent (90%) of shield wire strength.

(10) Bus support clamps for rigid bus shall be fixed or slip type as required to firmly support the bus but allow for temperature expansion and contraction.

(11) Bolted ground connectors and flexible type grounding jumpers shall be provided for operating handles of disconnect switches.

(12) All transformer and oil circuit breaker stud connectors shall be tinned bronze material.

(13) All grounding connectors in contact with galvanized structures shall be tinned bronze material.

(14) All compression tees are to be open type compression run and 4-hole NEMA pad tap.

(15) Bundled jumpers from power circuit breakers to disconnect switches shall be furnished.

(16) For disconnect switch connections, NEMA-type terminal pad connectors shall be provided with at least four (4) bolts.

(17) All materials furnished shall have mechanical and electrical ratings, types, sizes, and other similar items coordinated with adjacent hardware and fittings.

(18) All hardware furnished shall be static-free type.

(19) Ground jumpers shall be provided direct from switch-operator ground pad to ground connector on operating handle or mechanism of switch. No other ground connection is to be made to pad. Ground mat(s) shall be furnished at each switch-operator.

(20) Bus grounding stud, welded or swaged, shall be furnished as indicated.

(21) Wire guides and bundle conductor spacers shall be provided as required and indicated to maintain adequate clearance and support on cable jumpers, connections, and overhead lines.

6.1.23 **Requirements for grounding system:**

(1) The grounding system/grid shall be installed throughout the Project Substation, including at least three (3) feet outside the perimeter fence of the Project Substation and shall be bonded to the fence as required to meet acceptable levels of both touch and step potential and ground potential rise. An additional three (3) feet shall extend beyond the swing radius of each 12-foot-wide (minimum) gate for grounding.

(2) The Project Substation grounding grid shall be designed in accordance with the methods and recommendations of IEEE 80 and using SES-CDEGS software or Owner-approved equal. The grounding system shall have adequate capacity to dissipate heat from ground current under the most severe conditions in areas of high ground fault current concentrations, with grid spacing such that safe voltage gradients are maintained. Project Substation ground conductors shall be sized for fault duration of 0.5 seconds.

(3) The grounding system shall be designed and constructed in accordance with NESC Section 9.

(4) The Project Substation grounding system shall be an interconnected network of bare copper conductor and copper-clad ground rods (ground wells may be used instead of ground rods if dictated by the soil analysis). The system shall be designed such that Project Substation personnel are protected from the hazards that can occur as the Project Substation grounding system provides the earth return electrode during power system phase to ground faults.

(5) Ground resistivity testing shall be performed *prior* to final design to determine ground analysis parameters. The ground resistivity shall be measured with the methods given in IEEE 81.

(6) Ground conductor size shall be sized accordingly to specific ground conditions and equipment requirements. Bare conductors to be installed below grade shall be spaced in a regular pattern that is consistent with the grounding analyses. Each junction of the grid shall be bonded together by an exothermal welding process. Above ground shall be NEMA two-hole connectors.

(7) All metallic structures within the substation shall be effectively grounded.

(8) Substation aggregate shall conform to ASTM C33, gradation 1.5 to No. 8 particles and shall have minimum resistivity of 3,000 ohm-meters. Aggregate must be fractured on at least 3 faces and cannot be round river rock.

(9) All grounding materials required shall be furnished new and undamaged.

(10) All clamps, connectors, bolts, washers, nuts, and other hardware used with the grounding system shall be made of copper. Within the Project Substation, below-grade connections shall be Cadweld (or approved equal); bolted fittings below grade are prohibited.

6.1.24 **Requirements for lightning protection:**

(1) Lightning protection shall be designed in accordance with IEEE 998.

(2) Overhead shield wires installed on the take-off towers and lightning masts shall be provided for protection from direct lightning strikes. The shield system shall be adequately bonded to the Project Substation ground grid.

(3) Steel masts for direct stroke protection shall be round tapered seamless extruded or spun aluminum tubes.

(a) The overall height of the masts above grade shall be determined from the direct stroke protection study, as more particularly described under the Project Substation Electrical Studies herein.

(b) Masts shall have a single uniform taper from top to bottom.

(c) Each mast shall be capped with a suitable finial.

(d) Each mast shall be equipped with an internal vibration dampening device.

(e) The design of masts shall have a safety factor of two (2) based on the allowable yield stress for the mast material in accordance with the latest ASCE specifications governing design of structures.

(f) The horizontal deflection at the top of each free-standing mast shall be limited to L/20 of its height above foundation.

(g) Each mast shall be installed on a concrete foundation with galvanized steel anchor bolts. Foundations, bolts, and welding shall be in accordance with the structural requirements in Section 4.1 herein.

(h) Each mast shall be provided with two grounding pads located 12 inches above the foundation.

6.1.25 **Requirements for lighting:**

(1) A lighting system shall be furnished for the Project Substation. The lighting system shall provide personnel with illumination for Project Substation operation and maintenance under normal conditions and means of egress under emergency conditions. Dark sky lighting is recommended.

(2) The lighting system shall be designed in accordance with IES standards to provide acceptable illumination levels. Lighting levels shall meet, at a minimum, the requirements of the NESC, including Table 111-1 therein.

(3) Outdoor lighting shall be LED type. Lighting sources and fixture selections shall be based on the applicability of the luminaries for the area under consideration.

6.1.26 **Requirements for equipment labeling:**

(1) All major equipment and devices shall be properly labeled with nameplates made of laminated three-ply plastic to meet Applicable Standards (including those for safety) and other Requirements.

(2) Nameplates shall be fastened to the equipment by using a minimum of one (1) blank rounded screw on each end. Nameplates shall be a minimum of 1/8-inch thick, with yellow outer layers on a black core. Nameplate edges shall be chamfered.

6.1.27 **Requirements for electrical equipment enclosures:**

(1) All control cabinets, pull boxes, and electrical junction boxes shall be in accordance with NEMA standards and type number and shall be suitable for the Project location conditions, including corrosivity. Minimum design shall be:

(a) Indoor: NEMA 1

(b) Outdoor: NEMA [3R/3S/3X/4X], stainless or aluminum [NTC: increase if needed for site-specific corrosion]

(2) All enclosures shall be provided with pad-locking provisions.

6.1.28 **Requirements for battery system:**

(1) Batteries shall be provided with racks, connection devices, tools, instruction books, protection shield covers, rail protection system, and other standard items. They shall also include redundant fans for the required ventilation. Such fans shall be installed directly above the location where batteries are to be installed.

(2) Battery charger requirements:

(a) One (1) fully-rated, self-cooled battery charger shall be installed. If multiple battery chargers are used, the battery chargers should be connected in parallel to charge the batteries simultaneously. The chargers will be served from the Project Substation AC system.

(b) Project Substation battery chargers shall be $125V_{DC}$ output, sized as required for eight (8)-hour recharge (following a complete discharge) while serving continuous load.

(c) Chargers shall include an AC circuit breaker in the charger input circuit to provide a disconnect point and overcurrent protection. Chargers also shall include DC ammeters, DC voltmeters, AC power failure alarm relays, high/low DC voltage alarm relays, ground detection alarm relays, and battery temperature compensation systems which reduce the charge rate if necessary.

(d) Chargers shall maintain output voltage within plus or minus one percent (1%) from no load to full load, with an input power supply deviation in voltage level of plus or minus ten percent (10%) and an input power supply deviation in frequency of plus or minus five percent (5%).

(e) Chargers shall automatically vary the charging rate in accordance with the requirements of the Project Substation battery.

(f) Each battery charger-eliminator furnished shall be self-regulating, natural cooled, solid-state silicon controlled full wave rectifier type designed for single and parallel operation with the batteries specified under the Specifications. Charger shall be able to provide the DC load requirements in the event that battery is disconnected.

(g) Solid-state electronic circuits shall have AC and DC transient voltage protection and shall be designed to recharge a totally discharged battery without overloading and without causing an interrupting operation of AC or DC circuit breakers.

(h) Charger shall be a full capacity charger and shall have the capacity to recharge the battery in a maximum of eight (8) hours following complete discharge. Charger shall also have an equalizing charge mode. Battery charger will be self-regulating after charging levels are manually selected. Battery charger shall be manufactured in NEMA 1 enclosures suitable for placement in an indoor, environmentally controlled atmosphere. Charger shall require only front access and will allow either top or bottom conduit/cable entry.

(3) The Project Substation shall include a DC system, including, but not limited to, batteries, two (2) battery chargers, and panelboards.

(a) Battery size shall be determined using the battery load profile.

(b) Nominal voltage shall be $125V_{DC}$ with 60 cells.

(c) Batteries shall be capable of being recharged to rated capacity from a discharge down to zero (0) volts per cell, following an equalization charge.

(d) Design shall be based on an eight (8)-hour discharge time to 1.75 volts per cell and the voltage is to be maintained for the design life of the battery.

(4) Each battery cell shall be wet cell, lead-acid pasted plate-type with lead-calcium alloy plate grids or sealed type. Cell containers shall be sealed, clear, shock absorbing, heat resistant plastic, with electrolyte high and low-level markers and spray-proof vents. Batteries shall be manufactured for full float service with a high discharge rate, low deterioration rate, and low maintenance. Batteries shall be supplied complete with all accessories (e.g., battery rack, inter-cell connectors). Racks shall be a two (2)-step configuration.

(5) The DC panel and bolted breakers shall have a main bus current rating as required to supply the connected load. The continuous current ratings and interrupting ratings of the feeder breakers shall be based on the available fault current and the characteristics of the connected loads or the battery chargers.

(6) The capacity of each battery shall be determined in accordance with IEEE 485 and the specifications herein. With the battery initially fully charged at the floating voltage specified, and with the battery chargers disconnected, the battery shall be capable of supplying the duty cycle specified. The ambient temperature during the duty cycle shall be 25°C.

(7) The duty cycle for battery sizing shall include (a) one (1) minute at the level of current required to operate all Project Substation circuit breakers plus the continuous load; (b) 478 minutes of continuous load (actual but not less than 15A); and (c) one (1) minute at the level of current required to operate all Project Substation circuit breakers plus the continuous load.

(8) The operating ambient temperature range shall be 0°C to 40°C,

6.1.29 **Requirements for raceway:**

(1) Raceway shall conform, at a minimum, to the recommendations included in IEEE 525.

(2) Raceway that contains multiple cable circuits shall have all cables with identical insulation ratings.

(3) Individual raceway systems shall be established for the following services: (a) 600-volt control cable; (b) special electrical noise-sensitive circuits; and (c) fiber optic cable.

(4) Hot-dipped, rigid galvanized conduit (after fabrication) shall be used for above-ground power and control cables.

(5) Flexible conduits shall be used only at locations where vibration is required; the maximum contiguous length of flexible conduit shall be three (3) feet.

(6) All raceway and conduit locations shall be coordinated with other equipment and structures. All raceway and conduit shall be installed perpendicular or parallel to the major equipment and bus structures.

(7) All raceway and conduit shall be installed in a neat, rectangular form. Special attention shall be given to securing a neat appearance.

(8) All raceway materials required shall be furnished new and undamaged in accordance with the following requirements, at a minimum:

(a) Duct: polyvinyl chloride, Schedule 40 PVC in accordance with NEMA TC-2.

(b) Couplings: plastic, for use with duct previously specified and “duct-to-steel” adapters as required, including joint cement.

(c) Spacers: plastic high impact, interlocking, base and intermediate type

(d) Factory bends and sweeps: Schedule 40 PVC, three (3)-foot minimum radius.

(e) End bells: plastic.

(f) Plugs: plastic, high impact, tapered to fit end bell provided.

(g) Riser termination: rigid hot-dip galvanized mild-steel coupling.

(h) Riser bends: rigid steel conduit elbows, factory or field made, three (3)-foot minimum radius, 90 degree, entirely concrete encased below grade; hot-dip galvanized rigid mild steel in accordance with ANSI C80.1 and UL 6; the conduit interior and exterior surfaces having a continuous zinc coating with an overcoat of transparent enamel or transparent lacquer.

6.1.30 **Requirements for metering:**

(1) The revenue meter shall be at the point of delivery as described in the Generator Interconnection Agreement. Each revenue meter shall be high accuracy and shall comply with the requirements shown in Exhibit [●] (*Power Purchase Agreement Exhibit Name*).

(2) Meters shall be installed on each medium-voltage (34.5-kV) Collection System Circuit feeder, although to the extent that the Communications System can register production by feeder, a separate physical meter for each feeder is not required.

6.1.31 **Requirements for protective relaying:**

(1) Protective relaying shall provide secure and selective isolation of equipment when necessary during faults, abnormal or hazardous operating conditions.

(2) All relays shall be microprocessor-based and wired to a central communication processor with IRIG-B time stamping. The communication processor shall integrate all relaying.

(3) Relay panels shall be located in the Project Substation control building and shall include all hard-wired and soft-wired protection and control interlocks. Relay panels shall be installed in a new control room.

(4) Protective relaying design and equipment selection shall be provided in accordance with the Requirements, including, but not limited to, the Applicable Standards and prudent electrical industry practices.

(5) All protection device settings shall be provided for Owner's review no later than 60 days prior to the system energization date.

(6) Programming of devices shall be provided in electronic format straight from the device.

(7) Owner will review and approve the final design prior to procurement of equipment.

(8) The local utility shall require review and confirm line protection and signal exchange requirements. Owner shall facilitate such reviews.

(9) Protection shall be provided for all breakers, bus, transformers, 34.5-kV lines, high-side lines, capacitors, and inductors.

(10) The relaying schemes shall monitor and respond to over-currents, phase faults, ground faults, and other system abnormalities. Protection schemes to be utilized shall include, but not be limited to, line impedance/differential, bus differential, transformer differential, breaker failure, backup relaying, switch into fault, and sync check.

(11) Annunciation and alarms shall be communicated to the Operator through an RTU that will signal loss of protection integrity including but not limited to: coil monitoring, loss of tripping power, gas pressure, relay failure, and other similar items.

(12) High-side lines shall include primary and backup relaying.

(13) Reserved.

(14) Main step-up transformer protection shall include primary and backup relaying and monitor for oil and winding temperature.

(15) Observe IEEE 1050 for protective instrument grounding.

(16) All relays shall have digital read-out on the front.

6.1.32 **Requirements for control building:**

(1) The control building shall be a new, prefabricated, weatherproof, climate-controlled building containing protective relaying and control and communications systems and equipment. All electrical equipment shall be installed in the building prior to shipment.

(2) The control building shall be located within the fenced area of the Project Substation with a minimum of 20 feet of clearance on all sides.

(3) The control building shall be grounded and include HVAC.

(4) The control building shall contain a data concentrator and communications processor to collect Project Substation data signals for facility use.

(5) The control building shall include adequate space and clearance for all Turbine Supplier-furnished Turbine SCADA System equipment as needed.

(6) Local user controls shall be included that are capable of overriding the controller if required for any reason. Local controls, including monitoring screens and keyboards, shall be placed in the control building.

6.2 Submittals

6.2.1 **Contractor shall prepare the Project Substation design documents per The Submittal Schedule and containing the following information, at a minimum: (a) design basis; (b) general arrangement plan and physical layout diagrams; (c) civil works drawings, including subgrade preparation, grading, drainage, and erosion control; (d) protection and control system designs and philosophies; (e) one-line diagrams, three-line diagrams, and wiring diagrams, including A/C and D/C schematics; (f) communications block diagram, including all Communications System equipment, Owner-Supplied Equipment (including Turbine SCADA System), and utility equipment; (g) Communications System details, including logic descriptions, points lists, rack layout diagrams, HMI screen development, and fiber termination diagrams; (h) cable specifications and arrangements; (i) conduit and cable schedules; (j) panel schedules; (k) loop drawings; (l) elevation drawings; (m) connector and fitting details; (n) structural design documents, including foundation plans and details (with structural calculations to be provided with each set of foundation drawings); shop drawings showing fabrication of structural-steel components; details of cuts, connections, splices, camber, holes, and other pertinent data; indication of welds by standard AWS symbols, distinguishing between shop and field welds, and showing size, length, and type of each weld; indication of type, size, and length of bolts, distinguishing between shop and field bolts; mill test reports and structural steel properties, including chemical and physical; and fastener properties (mechanical/chemical), including bolts, nuts, and washers, and indicating coatings used to satisfy anchor bolt protection plan; (o) ground grid plans; (p) metering diagrams; (q) conduit and trough plans; (r) fencing and gate details; (s) control building drawings; (t) drawing index; (u) bill of materials; and (v) inspection, testing, and quality control requirements.**

6.2.2 **Contractor shall prepare equipment specifications to define the requirements and properties for the procurement of all permanently installed Project Substation equipment and materials. The specifications shall be submitted to Owner for review prior to the procurement of the applicable equipment. The following specifications shall be provided, each as applicable to the design: (a) construction specification; (b) main power transformer; (c) control building, including enclosure and panels; (d) capacitor bank (if any); (e) reactor bank (if any); (f) disconnect switches; (g) capacitor switcher (if any); (h) reactor switcher (if any); (i) breakers (high voltage, medium voltage, cap/reactor); (j) neutral grounding reactor; (k) potential transformers; (l) current transformers; (m) voltage transformers; (n) CCVTs; (o) surge arresters; (p) station service transformer; and (q) grounding transformers (if any).**

6.2.3 **Contractor shall submit manufacturer's approval drawings or product sheets (material cut sheets) for all permanently installed Project Substation equipment and materials, including all items identified in <u>Section 6.2.2</u> above as well as busswork, metering, relays, and gravel/aggregates.**

6.2.4 **Contractor shall prepare a set of studies and analyses for the Project (collectively, the "Project Substation Electrical Studies") to demonstrate the adequacy of the proposed electrical system design, including any studies and analyses that may be necessary to ensure compliance with the Requirements, including the Applicable Standards or utility requirements. The Project Substation Electrical Studies shall be submitted to Owner for review *prior* to the procurement of the applicable Equipment. The following shall be included in the Project Substation Electrical Studies, at a minimum:**

(1) Substation Grounding Report: grounding system study of ground grid conductors and interconnection (if any) with the ground grid. The study shall confirm that the grounding system maintains touch and step voltages within tolerable limits, and shall be prepared in accordance with the procedures, data, and recommendations given in IEEE 80. The study shall determine the ground potential rise with respect to remote earth.

(2) Effectively Grounded Report: study to confirm the Project is considered effectively grounded, as defined in IEEE C62.92.1-2000.

(3) Substation AC System Study: calculation of the capacity of the low-voltage AC systems in the Project Substation to determine size of station service.

(4) Substation DC System Study: calculation of the capacity of the batteries and chargers within the Project Substation with the DC service required for the equipment at the substation, as determined from a load profile developed for all DC loads. The study shall determine if the minimum voltages are maintained as specified and required by equipment vendors. The DC system shall be sized to accommodate future loads for ultimate switchyard configuration.

(5) Substation Bus Ampacity Study: calculation of bus ampacity in the Project Substation based upon continuous current rating as given on the one-line diagram and Project Site-specific conditions.

(6) Substation Bus Structural Analysis Study: analysis of bus structural design in the Project Substation including bus, insulators, bus structures, and foundations, and based upon the most stringent combination of wind, fault current, and ice load factors, as defined in the Applicable Standards and other applicable Requirements.

(7) Substation Bus Design Study: analysis of the performance of the buses, disconnect switches, and separately-mounted current transformers within the Project Substation to confirm that the ampacity, structural integrity, vibration, and required mechanical and electrical ratings are in accordance with the methods and recommendations of IEEE 605. Bus design, including gust factor, exposure height factor, importance factor, and corona considerations, shall be in accordance with the procedures and data given in IEEE 605.

(8) Substation Lighting Study: lighting illumination calculations for the Project Substation to determine the illumination levels within the new substation that will be achieved with added luminaries.

(9) Substation Lightning Study: direct stroke protection analysis for lightning at the Project Substation based upon Project Site-specific determinations for thunderstorm days, thunderstorm duration, isokeraunic levels, exposure, and other similar factors. The direct stroke protection system design shall include analysis using the rolling sphere method of the electrogeometric model given in IEEE 998. The direct stroke protection system design shall be in accordance with the procedures, data, and methods given in IEEE 998.

(10) Arc Flash Study: arc flash hazard analysis of the Equipment, including all energized equipment in the Wind Turbines, Collection System Circuits, Project Substation, Interconnection Line, and O&M Building. This analysis shall be performed in accordance with the latest version of NFPA-70E and IEEE 1584.

(11) Protection Coordination Study: relay and protection equipment coordination study, including detailed calculations, one-line and three-line diagrams, fuse curves, coordination curves, protected equipment data, and relay set points. This study shall include the Wind Turbine equipment (including switchgear / converter), Collection System Circuits, Project Substation, and Interconnection Line. This study shall also consider and coordinate with the interconnection utility's reasonable requirements. A narrative philosophy statement shall be submitted for comment before completing the coordination study, and the proposed settings for the Wind Turbine switchgear / converter shall be delivered to Turbine Supplier for implementation *prior* to energization. Contractor shall be responsible for obtaining approval from the Utility for the proposed relay settings and coordination with the Utility's protection and control scheme.

6.2.5 **Contractor shall prepare a set of studies and forms for the Project (collectively, the "NERC Compliance Studies") to meet NERC Regulatory Standard Requirements. The NERC Compliance Studies shall contain all studies summarized below, at a minimum:**

(1) FAC-002-2: Facility Interconnect Studies (to be completed prior to synchronizing)

(2) FAC-008-3: Facility Ratings (to be completed prior to synchronizing)

(3) MOD-025-2: Verification and Data Reporting of Generator Real and Reactive Power Capability Model (model to be completed prior to synchronizing, with model verification to be completed during commissioning). Test plan to be provided by Contractor, although actual testing to be performed by others following turbine commissioning.

(4) MOD-026-1: Verification of Models and Data for Generator Plant Volt/VAR Control Functions (model to be completed prior to synchronizing, with model verification to be completed during commissioning). Test plan to be provided by Contractor, although actual testing to be performed by others following turbine commissioning.

(5) MOD-027-1: Verification of Models and Data for Active Power / Frequency Control Functions (model to be completed prior to synchronizing, with model verification to be completed during commissioning). Test plan to be provided by Contractor, although actual testing to be performed by others following turbine commissioning.

(6) MOD-032: Steady State, Dynamic, and Short Circuit Modeling Data (model to be completed prior to synchronizing, with model verification to be completed during commissioning). Test plan to be provided by Contractor, although actual testing to be performed by others following turbine commissioning.

(7) PRC-001-1.1: System Protection Coordination (to be completed prior to synchronizing). Contractor shall (a) address any relay settings required to meet PRC-026 for Performance during Stable Power Swings and (b) coordinate with Owner regarding additional documentation that may be required due to the upcoming PRC-027 standard (effective October 1, 2020); such standard is expected to replace some of the requirements currently included in PRC-001.

(8) PRC-005-3(i): Protection System and Automatic Reclosing Maintenance (dated testing records required prior to synchronizing)

(9) PRC-019-2: Voltage Regulating Controls (to be completed prior to synchronizing)

(10) PRC-024-2: Frequency and Voltage Relays (to be completed prior to synchronizing)

(11) PRC-025-1: Generation Relay Loadability (to be completed prior to synchronizing)

(12) PRC-026-1: Relay Performance During Stable Power Swings

(13) PRC-027-1: Coordination of Protection Systems for Performance During Faults (to be completed prior to synchronizing)

(14) FAC-008: Guidance on Facility Ratings

(15) VAR-002: Generator Operation for Maintaining Network Voltage Schedules

(16) CIP-003 Cyber Security - Security Management Controls

6.2.6 **Contractor shall prepare energization plans and procedures for the Project Substation. Energization plans shall be submitted to Owner for approval *prior* to use. Energization plans shall include both electrical and communications infrastructure as well as backfeed plans, soaking plans, testing plans, and lock out tag out procedures, at a minimum.**

6.2.7 **Contractor shall provide a complete recommended spare parts list for the Project's electrical works, including the Project Substation. Such list shall include recommended quantities, part / model numbers, and nominal pricing.**

6.3 Collector Substation

6.3.1 **Contractor shall design, furnish, construct, and install one (1) [34.5/###]-kV Project Substation in conformance with the minimum requirements set forth herein, Exhibit 8 (*MP Substation Specifications*), and the [preliminary] design documents in Exhibit [●] (*Design Documents Exhibit Name*).In the event of conflicting information between the minimum requirements set forth herein and Exhibit TBD (*MP Substation Specifications*), the Owner Specifications shall prevail.**

(1) The Project Substation shall be constructed at the location shown on Exhibit [●] (*Project Site Plan Exhibit Name*).

(2) Contractor shall furnish all labor, equipment, and materials that are necessary for a complete, fully-functional, and safe Project Substation configuration, excluding only the Owner-Supplied Equipment in Exhibit [●] (*Owner-Supplied Equipment*).

(3) Contractor shall not combine (bifurcate) feeders into a single medium-voltage breaker within the collector substation.

6.3.2 **Contractor shall furnish all capacitor banks, reactors, and/or other reactive compensation equipment necessary for the Project. Contractor shall also furnish all VAR-control logic (including switching) and program such logic into the substation RTU.**

6.3.3 **Contractor shall furnish and install fencing and gates at the Project Substation.**

(1) The Project Substation perimeter shall be fenced. The fence shall be tied into the Project Substation grounding grid.

(2) At least two 2(2) vehicle gates shall be installed at the Project Substation. The vehicle gates shall be a 12-foot-wide (minimum), manual, swing, locking gate..

(3) At least one (1) pedestrian gate shall be installed at the Project Substation. The pedestrian gate shall be a 4-foot-wide (minimum), locking, manual swing-gate for personnel access.

(4) All fencing and gates shall comply with the minimum specifications in Section 4.1.8 herein.

(5) Contractor shall furnish and install a contact sign at the entrance to the Project Substation, as described in Section 2.5 herein.

(6) A minimum of four(4) inches of *washed* crushed aggregate shall cover the entire Project Substation footprint, including those areas reserved for future build-out, *plus* a minimum of four (4) feet outside the perimeter fence, to help reduce touch and step potentials. A greater level of washed crushed aggregate shall be installed if necessary to meet the Requirements and satisfy the recommendations set forth in the Geotechnical Report. Any areas at the Project Substation to be utilized for traffic must be suitably compacted to support traffic loads.

6.3.4 **ContractorFor purposes of the Proposal, a CCTV system will not be installed at the Project Substation, although Contractor shall install conduits and gang boxes (including covers for gang boxes) and leave appropriate space for future installation.**

6.3.5 **Contractor shall furnish and install the main power transformer(s), including offloading, setting, completing all terminations (power, control, and grounding), dressing, filling with oil, testing, and commissioning of the unit(s).**

6.3.6 **Contractor shall furnish and install the revenue meter(s).**

6.3.7 **Contractor shall furnish and install ANSI-approved arc flash labels in the warning of the dangers of arc flash. Such labels shall be supplied and affixed to any equipment that may require service or maintenance while energized, as specified in the Contractor-provided arc flash study, including the Wind Turbines, Collection System Circuits, Project Substation, Interconnection Line, and O&M Building.**

6.3.8 **Contractor shall provide the following, each as more particularly described in the Generator Interconnection Agreement:**

(1) [NTC: add specific requirements from GIA (typically in Appendix)]

6.3.9 **Contractor shall provide backup power at the Project Substation via the local distribution system or a standby generator; the battery system may not be utilized as backup power source. The backup power shall be installed within one (1) week of control building delivery to Project Substation.**

6.4 Testing and Quality Control

6.4.1 **Contractor shall test, commission, start-up, and place into successful operation the Project Substation, including the electrical infrastructure and communications infrastructure. At a minimum, testing shall be in conformance with the following minimum requirements. All testing shall be performed by an independent, experienced third party. The third party shall provide the Owner with yellow-lined testing documentation for the Project Substation.**

(1) All Testing and Quality Control for the Project Substation shall comply with the applicable specifications in Exhibit 8 (*MP Substation Specifications*). In the event of conflicting information between the minimum requirements set forth herein and Exhibit 8 (*MP Substation Specifications*), the Owner Specifications shall prevail.

(2) All Project Substation equipment shall be tested to demonstrate it meets stated design criteria and is fit for purpose.

(3) All testing specified in the Applicable Standards, including NETA.

(4) All testing reasonably recommended or required by the applicable equipment suppliers.

(5) All exposed cable sections shall be visually inspected for physical damage or manufacturing defects. Such inspections shall be performed prior to and during installation.

(6) Insulation testing of all installed cables.

(7) Point-to-point wiring checks of all installed wiring.

(8) After completion of wiring installation work, all circuits shall be tested for continuity, grounds, shorts.

(9) Breaker function testing.

(10) PT/CT turns ratio and polarity testing.

(11) Breaker contact resistance testing.

(12) Ground resistance and continuity testing.

(13) Surge arrester testing.

(14) Instrument transformer testing.

(15) Ground grid testing.

(16) Relay functional testing.

(17) Disconnect switch testing.

(18) Reactor / capacitor bank testing (if applicable).

(19) Control building testing.

(20) Minimum main step-up transformer testing, all on the purchased unit(s):

(a) All tests identified as "Routine" in IEEE C57.12.00 Table 18 and performed in accordance with IEEE C57.12.90.00.

(b) Temperature rise at the maximum 65°C rating.

(c) Temperature indicator accuracy test.

(d) Induced potential test with the transformer connected at high voltage, with the transformer's own bushings in place, accompanied by partial discharge monitoring (to conform to ANSI C57.12.90).

(e) Impulse tests on all winding terminals, with the transformer's own bushings in place.

(f) Switching surge tests on the high-voltage winding, with the transformer's own bushings in place.

(g) Test all control wiring for continuity, grounds, and correct connections; and test operation of all relays, indicators, switches, lights, and interlocks.

(h) Resistance measurements of all windings on the rated voltage connection and all load tap connections. Test results shall be reported in ohms at 85°C

(i) Doble insulation power factor tests conforming to Method II in Table 4 of Article 10.10 of ANSI C57.12.90. The power factor shall be equal to or less than 0.5% at 20°C.

(j) Sample tests of the transformer insulation system shall be in accordance with IEEE C57.100. The test results shall confirm the specified minimum transformer insulation life expectancy when operated at the average winding temperature rise given in IEEE C57.12.00.

(k) Load loss and no-load loss testing. Loss tests shall conform to the requirements of IEEE C57.12.90 and IEEE C57.123. Each unit shall have an auxiliary power (C57.12.00 - control (auxiliary) cooling losses) test or calculation. Auxiliary power test or calculation shall include peak simultaneous power consumption in all cooling equipment within the range of transformer rating and specified service conditions. Differences between the guaranteed values and test values for load loss, no-load loss, and auxiliary power shall result in adjustments in accordance with the commercial terms and conditions.

(l) Perform the supplier's standard tests on each surge arrester.

(m) Zero sequence.

(n) SFRA, at factory and at Project Site. The test shall be performed in accordance with IEEE Std C57.149. Digital output files from test equipment shall be supplied for comparison with future tests.

(o) Mineral oil tests: mineral oil tests for conformance with the ASTM limits shall be conducted in accordance with the ASTM standards listed in ASTM D3487. Mineral oil tests for conformance with IEEE limits shall be conducted in accordance with IEEE Std. C57.106. Corrosive sulfur shall be tested in accordance with ASTM D1275 Method B.

(p) Audible sound pressure level tests to verify specified sound pressure level shall be made for one unit of each transformer design and ratings included in this specification. Tests shall be conducted with the specified OLTC; the OLTC shall be at the principal tapping. Measurements shall be made with the transformer at rated power and shall be included in the test report. No-load and rated load audible sound level measurement shall include A-weighted and discrete frequency narrow band tests in accordance with the sound level measurement procedure given in IEEE C57.12.90.

(q) Bushings with specifications in conformance with IEEE C57.19.00 shall have type tests, special tests, and routine tests that conform to the requirements of IEEE C57.19.00

(r) Type tests and routine tests for CTs shall conform to the requirements of IEEE C57.13. Current transformers specified to be metering accuracy shall be tested at burdens B0.1, B0.5, and B1.8 for all secondary current of 0.5, 1.0, 2.0, 3.0, 4.0, 5.0, and 7.5 amperes. High accuracy CTs shall be tested in accordance with IEEE C57.13.6.

(s) DETC testing: DETC shall have type tests and routine tests that conform to the requirements of IEC 60214-1. A motor drive shall have type tests and routine tests that conform to the requirements of IEC 60214-1.

(t) OLTC testing: (1) design tests for an OLTC shall conform to the design test requirements of C57.131 and this specification; (2) dielectric tests for Category 1 and Category 2 OLTCs applied in transformers with the highest voltage of 550 kV shall have the test voltage levels from IEC 60214-1, Table 5; (3) partial discharge tests shall generally follow the test methods and instrumentation of IEEE C57.12.90, Annex A, and partial discharge tests for OLTC with nominal voltage of 500 kV shall have an extended period phase-to-ground voltage of 475 kV, and the enhancement phase-to-ground test level of 550 kV; and (4) the additional impedance voltage and load-loss tests listed in C57.12.00 shall be performed for one unit of each set of ratings included herein.

(u) Owner shall be permitted to attend all main power transformer testing, including factory acceptance testing. Contractor shall provide at least 30 days advanced notice to Owner of such testing.

(21) All Project Substation foundations shall be tested for concrete and grout properties (strength, slump, air content, temperature).

(22) Compaction.

(23) Other testing set forth in the [preliminary] design documents in Exhibit [●] (*Design Documents Exhibit Name*).

6.4.2 **Contractor shall notify Owner of all testing schedules at least 30 days in advance of testing activities and copies of testing reports (including a summary of testing procedures and acceptance criteria) shall be submitted to Owner within 10 days of completing such test.**

7.0 INTERCONNECTION LINE

1.1 Introduction

A. Section 8 of this, Exhibit 1, shall form the technical basis for the design, material procurement, and construction of the Gen-Tie line between the Wind Substation to POI.

1.2 General

A. A new single circuit XXX kV Gen-Tie line, to be installed on self-supporting tubular steel poles (or Owner approved structures), shall begin at the Wind Substation and terminate at Point of Change of Ownership as defined in the Interconnection Agreement.

B. Contractor shall be responsible for the following:

1. Perform Gen-Tie line engineering, analysis, and design.
2. Prepare a complete construction package to include the following: final plan and profile drawings, sag charts, stringing tables, complete bills of material, structure list, structure foundation drawings, structure erection drawings, insulator and hardware assembly drawings, right-of-way constraints, phasing, outage constraints with complete schedule, and construction technical provisions.
3. Procure equipment and material.
4. Receive, inventory, store, and protect equipment and material.
5. Install the line.
6. Test and commission.
7. Prepare as-constructed documents, which shall include the gen-tie facilities, right-of-way widths, easement areas, fences and gates, and labeling of all major roads and points of interest in both AutoCAD and pdf formats. In addition, prepare as-built PLS-CADD model and all supporting documentation.

C. It shall be Contractor's responsibility to complete all tasks necessary to provide Owner with a complete and fully functional Gen-Tie line facility that meets all Owner's standards and specifications, including the Interconnection Agreement.

D. Contractor shall review and comply with all permit requirements and stipulations.

1.3 Gen-tie Line Engineering and Design

A. General Requirements.

1. The design specifications and drawing requirements provided or referenced in this document are to be considered as minimum requirements. Any criteria not

specifically addressed in this specification shall as a minimum meet or exceed the requirement of the current edition of the National Electric Safety Code (NESC) C2.

2. The Facility Ratings shall be calculated using assumptions from MP's Facility Rating Methodology. See Exhibit 14 for methodology.

3. Contractor shall use PLS-CADD software to spot and perform detailed analysis and design of the gen-tie line.

4. OPGW (including a primary and secondary (redundant) OPGW) shall be installed the entire length of the overhead route and coordinated with the SCADA System/communication/protection specification. Based on project details, Owner may waive redundancy requirement.

5. The Interconnection Line shall be designed and constructed to meet guidelines set forth by the Avian Power Line Interaction Committee.

B. Survey

1. The survey firm is responsible for establishing a ground control network and collecting controlled, color, digital, ortho-rectified photography and terrain data. Terrain data shall be collected using LiDAR. The survey firm is also responsible for processing the raw data and delivering a digital elevation model in a format readily imported into PLS-CADD.

2. Contractor shall be responsible for identifying and obtaining any additional survey data needed for design.

C. Right-of-Way

1. The Gen-tie shall fit within defined right-of-way while adhering to all NERC and NESC regulations.

2. Minimum horizontal clearance from the wires to the edge of the right-of-way shall be determines using the following criteria:

   a. Load Cases A and B are based on maintaining clearances to buildings. Clearances shall be at minimum 4.5 feet greater than NESC required clearances. See NESC 234 C.1.

   b. Load Case C is intended to keep the wires within the right-of-way or away from adjacent circuits during extreme wind conditions.

   c. When determining the location of the conductor at blowout conditions, the deflection of the structure must also be considered. For single shaft steel poles, the maximum structure pole top deflection shall be assumed at 8% of structure above grade height for the Extreme Wind case (Load Case C) and shall be prorated for the 6psf wind case.

Load Case A	a) 120 °F, Final sag b) Maximum operating temp, Final sag c) 32 °F with radial thickness of ice for the loading district, Final sag d) Minimum conductor temp, Initial sag
Load Case B	6 PSF Wind, No Ice, 60°F, Final
Load Case C	300 Year MRI Extreme Wind

D. Geotechnical.

1. Contractor shall be responsible for obtaining all geotechnical data needed for foundation design. Boring should be done at every engineered foundation location.
2. A project-specific geotechnical investigation shall be performed to obtain information from field and laboratory testing to provide soil strength properties to be used for foundation design.
3. Borings shall be taken at each dead-end structure, failure containment structure (if any), and PI location with a line angle of 2 degrees (2-deg) or greater. Additional borings shall be taken at convenient locations such that adjacent borings are no more than one (1) mile apart.
4. Borings should also be taken at any location where the terrain changes may indicate a significant change in the geotechnical properties of the soil.

E. Foundations

1. All steel pole structure foundations shall be of an engineered foundation type such as drilled pier, vibratory caisson, micro pile, helical pile, etc.
2. All foundations shall have a minimum projection of one foot (1 ft) above ground level or 1 ft above 10-year flood levels. Anchor bolt/base plate type foundations shall utilize anchor bolts with a separate full length rebar cage.
3. Drilled pier foundation diameters shall include a clearance of the larger: three (3) times the vertical reinforcement bar diameter or six (6) inches between the face of the vertical reinforcement and the face of the anchor bolts.
4. No steps in casing are permitted in the top 8 feet of a drilled pier hole.
5. The following parameters shall be used to design the foundations:
    a. The foundation designs will utilize a Load and Resistance Factor Design (LRFD) design methodology.
    b. The FAD tools software suite will be utilized for geotechnical and structural design. Monopole structures will be analyzed with MFAD.

Alternative software, such as LPile, will be considered on an as-needed basis to evaluate multi-pole structures to understand group effects.

c. Overload and Strength Factors

i. The below Table provides a summary of the overload and strength factors that will be used for design. It is assumed all foundation loading for design includes Owner and code required overload factors.

Overload and Strength Factors	
Overload Factor	1.1
Lateral SRF	0.63
Skin Friction SRF	Refer to FAD Tools Manual
End Bearing SRF	
Concrete Design SRF	Per ACI 318

d. Drilled pier minimum diameter will be determined by adding the project required clear spacing, clear cover, assumed longitudinal bar size of #11 and shear tie bar size of #5 to the assumed anchor bolt template diameter. In the absence of vendor anchor bolt drawings, the anchor bolt template is assumed to be 6” greater in diameter than the anchor bolt circle.

i. Side Shear Springs in FAD will be utilized as follows:

- Springs On
  - Site specific borings
  - Competent rock
- Springs Off
  - Assumed soil borings
  - Clay, soft soils, or shallow groundwater
  - Use of casing anticipated

e. 5ft of soil will be ignored to account for construction disturbances and frost unless otherwise noted in the geotechnical report.

f. Ground water will be placed at boring-specific depths as recommended by the project specific geotechnical report. If no design values are provided, water will be assumed to be a minimum of 3ft shallower than the observed boring depth to account for seasonal fluctuations. Additionally, any pier located in swamp, marsh, wetland etc. will be designed for water at grade.

g. Minimum Embedment

- Soil – 3x Pier Diameter
- Rock – Min 2x Pier Diameter overall with at least 1x Pier Diameter into competent rock.

h. Axial capacity may be spot checked in HFAD for monopoles at the Engineer’s discretion.

i. Deflection criteria for drilled piers is summarized in the below table. Deflection requirements will be verified against fully factored loads. Max deflection limits shall be satisfied at the top of the pier.

Top of Drilled Pier Lateral Deflection Criteria	
Total Deflection	4% Pier Diameter
Total Rotation	1°
Non-Recoverable Deflection	2% Pier Diameter
Non-Recoverable Rotation	0.5°

*FAD will not flag criteria violations at top of pier, engineer must verify manually

j. Concrete design parameters will be as summarized in the table below:

Concrete Design Parameters	
Concrete Strength	3,500psi for design 4,500 psi for construction
Max Agg.	0.75”
Min Long Bar Spacing	4” (ACI 336 5.2.2)
Reinforcement	ASTM A615 Grade 60 (60ksi)
Clear Cover	6” (FHWA 12.4)
Clear Spacing	4” (ACI 336 5.2.2)
Long. Bar Design	ACI Column Method
Concrete Shear Strength	ACI Method**

**Shear tie spacing not to exceed 12” for reinforcing cage rigidity

F. Structures

1. Type and Finish
    a. Structures shall base plated tubular steel.
    b. For multiple piece poles, deadend and angle structures shall use flange connections. Tangents may use slip joint connections.
    c. Structures shall have a Corten finish.
2. Structure Marking
    a. All structures shall be furnished with brackets for installing aerial markers. Aerial marker signs are required on:
    b. The first and last structures of a line (terminal structure at every substation)
    c. Structure numbers ending in either "0" or "5"
    d. Structures on each side of major road or water crossings
    e. Structures on each side of major line crossings
    f. All structures shall be furnished with brackets for installing structure numbers at the pole base. The ground markers shall be located on the transverse faces of the structure to be seen by road patrols.
3. Distribution underbuild will not be allowed.
4. Structure Spotting
    a. Structures shall be spotted so that all applicable clearances are maintained. The center of a structure should be located no closer than:
        i. 5 ft to the edge of a railroad right-of-way, for dead-end structures 8 ft shall be used.
        ii. 5 ft to the edge of a state/county rural road right-of-way, for dead-end structures 8 ft shall be used.
        iii. 10 ft to the edge of a pipeline right-of-way.
5. Vertical clearances shall be maintained when the conductor is at its greatest sag resulting from either the maximum operating temperature or the maximum loaded condition.
6. Structures shall be spotted in such a way that suspension attachments for conductors and shield wires shall not be in uplift at a temperature of -40°F initial sag and no wind.
7. Failure Containment Structures

a. Structure spotting for 115 and 230kV transmission line shall incorporate failure containment structures at intervals not exceeding ten miles. 345kV and above shall incorporate failure containment structures at intervals not exceeding five miles. The full-tension dead-end criteria shall be met by any failure containment structure.

G. Grounding

1. Continuous bonding shall be provided for all pier foundations between the rebar cage to the anchor bolt cage and to the steel pole in order to reduce ground resistance.

2. Grounding shall be connected to the steel pole utilizing a stainless steel grounding plate or 1/2" stainless steel nut welded to surface of the pole. Typical locations are the base of the steel pole close to base plate, the crossarms close to the insulator attachments, and the shield wire peak or crossarm close to the attachment points.

3. All transmission structures shall be individually grounded through a dedicated earth driven system composed of ground rods. The grounding resistance shall be measured on each structure prior to the installation of any overhead wire. The number of ground rods required to obtain the structure ground resistance is dependent on the soil resistivity. Additional rods shall be installed to reach acceptable structure grounding resistance of 25 ohms. The rebar cage and anchor bolt cage shall be bonded to the steel pole to reduce ground resistance for all pier foundations.

4. Shield wires and OPGW shall be bonded to the pole grounding system using a suitable ground wire.

H. Loading Conditions and Load Cases:

1. The criteria established in this document shall meet or exceed the requirements of the latest edition of the National Electrical Safety Code (NESC) C2. Any criteria not specifically addressed in this specification shall, at a minimum, meet or exceed the requirements of the latest edition of the NESC C2.

2. NESC Load Cases (NESC Section 250)

   a. NESC 250B, C, & D shall apply to all structures at minimum.

   b. All structures with arms shall also include in the vertical load component of Load Case 250B the weight of a worker and equipment equal to 500 lbs multiplied by the vertical overload factor of 1.5. This load is to be applied to each wire attachment point to design the arms.

3. Reliability Load Cases (300 year Return Period)

   a. The minimum extreme radial ice with concurrent wind load required by the current edition of the NESC is a 50-year return period load. For increased reliability, 300 year return period extreme ice with concurrent wind and extreme wind load cases shall be used for the design of the Gen-Tie Line.

4. Deflection

   a. Deflection at the pole tip shall be limited to 1% of the total structure height. All structures with arms shall also include in the vertical load component the weight of a worker and equipment equal to 500 lbs multiplied by the corresponding vertical overload factor. This load is to be applied to only one wire attachment point at the controlling location to maximize deflection.

   b. Full DE structure deflection shall be analyzed under NESC 250B loading conditions.

   c. All other structure deflection shall be analyzed at an average everyday load condition.

5. Broken wire and Unbalanced Ice

   a. The longitudinal load shall be applied at any one shield wire or one conductor (phase) position, whichever produces the most severe loading condition. The wind span at the broken wire (phase) position shall be assumed as 60% of the intact wind span. For the remaining intact wire (phase) positions full (intact) wind and weight span loads shall be used.

   b. For arms with a shield wire and conductor attachment (if applicable), the one load creating the most severe condition shall be applied, not both. Broken wire case shall be analyzed for one broken wire at a time. For bundled conductors, the broken wire case shall consider both wires of the bundle broken, one phase at a time.

   c. The differential tensions for unbalanced ice shall be calculated for the 300-year MRI equivalent radial ice load on all conductors and shield wires on one side of the structure and no ice on the other side. All wires shall be intact on both sides.

   d. For suspension type attachments, the conductor tension for the Broken Wire or Unbalanced Ice differential tension load shall be multiplied by 0.70. The Broken Wire or Unbalanced Ice load at the shield wire position shall not be reduced.

6. Construction

   a. This load case shall be used on all structures at all voltages with arms. The vertical load shall consist of the wire tension with overload factor of 1.1 at a three horizontal to one vertical stringing slope plus the weight of all hardware, stringing equipment, and the weight of one worker (500 lbs minimum) times the overload factor of 1.5.

b. The transverse load shall be based on the structure's actual wind span.

c. The longitudinal load shall be based on the assumption that the wire gets caught in the stringing block at a three horizontal to one vertical slope.

d. This Construction load is to be applied to one wire attachment location at a time with all other wire attachments intact at the stated Construction case weather conditions and overload factors.

7. Fall Protection

a. This load case shall be used on all structures at all voltages with arms. The vertical load shall consist of the vertical load in the load case plus an additional 5000 lbs. This Fall Protection load is to be applied to one wire attachment at a time with all other wire attachments intact under the stated Fall Protection case weather conditions and overload factors.

8. Load Case Application

a. Terminal dead-end structures shall consider all load cases defined for the project. Loading combinations for both "all wires intact" and "all wires removed from one side" or "partial wires on both sides" must be considered. These structures shall be designed for any combination of intact and/or dead-ended wires that create the highest stress in the pole under each of the load cases considered and their respective load factors.

b. All load cases must be analyzed for both single and double circuit installations. All shield wire and/or OPGW loading must be applied in all cases. Load case application by structure type is as follows:

Str. Type	**NESC 250B**	**NESC 250C**	**NESC 250D**	**300 Yr Ice & Wind**	**300 Yr Wind**	**DE Defl.**	**Susp. Defl.**	**Brkn Wire**	**Unblc Ice**	**Const.**	**Fall Prot.**
Suspension	X	X	X	X	X		X	X	X	X	X
Terminal Dead-End	X	X	X	X	X	X				X	X
Failure Containment	X	X	X	X	X	X				X	X

I. Wire Tension Limits.

1. The following maximum tension limits shall be applied to the conductors and shield wires:

Weather Case				Tension Limit
Wind (psf)	Radial Ice (inches)	Temp (°F)	Condition	Project Specific Limit
4	0.5	0	Initial	60% RBS
0	0	0	Final	25% RBS
0	0	0	Initial	35% RBS
300 Yr Ext. Wind	300 Yr Ext. Wind	300 Yr Ext. Wind	Initial	80% RBS
300 Yr Ext. Ice & Wind	300 Yr Ext. Ice & Wind	300 Yr Ext. Ice & Wind	Initial	80% RBS

2. Tensions shall be limited to protect the conductor against damage due to vibration.
3. Tension limits assume the use of vibration protection devices but shall not exceed the limits specified by manufacturer recommendations.
4. A vibration analysis shall be performed by the damper manufacturer to determine the requirement and placement of spacers, spacer-dampers and/or dampers for single conductors, conductor bundles, shield wires and OPGWs.
5. The OPGW and shield wire's final after creep sag shall not exceed 80% of the conductor's final after creep sag at 60 °F, but shall not exceed the specified tension limits to protect the shield wire and OPGW against damage due to vibration.
6. Tension limits may consider the use of vibration protection devices but shall not exceed the limits specified.
7. Stringing tensions for the OPGW shall not exceed 20% of the ultimate cable strength.
8. The bi-metallic conductor properties shall account for aluminum strands going into compression for ACSR conductors at temperatures greater than 167 °F. When aluminum strands can go into compression, a value of 1.5 ksi can be used for modeling maximum compressive stress in PLS-CADD.

9. ACSR with a steel content by area less than 7.5% shall be designed for a Maximum Operating Temperature of 167°F, all other ACSR shall be designed for a MOT of 212°F and ACSS/TW for 482°F.

10. Conductor stretch due to Creep shall be evaluated at 60 °F and no wind.

11. Conductor stretch due to Load shall be evaluated at the 300 year MRI Extreme Ice with Concurrent Wind load case.

12. Sagging charts produced for construction shall take into account conductor sagging tolerance while maintaining final installed tensions below the stated limits.

J. Electrical Clearances.

1. All systems are considered effectively grounded where ground faults are cleared by promptly de- energizing the faulted section, both initially and following subsequent breaker operations.

2. Basic ground clearances are designed to meet a minimum of NESC clearance plus a buffer not less than 4 feet. For clearance criteria not specified within this document, minimum clearances defined in the latest edition of the NESC C2 code shall be applied.

3. Working Clearances (MAD)

   a. Minimum Approach Distances (MAD) are provided in the following table:

Transmission Line Characteristics	Voltage Base (kV)	Minimum Approach Distance	
		Phase to Ground (ft-in)	Phase to Phase (ft-in)
MAD	115	3-9	4-8
MAD	230	6-8	10-2
MAD	345	11-3	18-2
MAD	500	16-8	27-1

*Values From Minnesota Power Safety Manual

4. Galloping Clearances Between Ellipses

   a. Single loop galloping shall be used for spans of 700 feet or less where galloping ellipses shall be calculated using the A.E. Davison method.

Double loop galloping shall be used for spans of 700 feet or greater utilizing the Toye calculation method. The line shall be designed such that the galloping ellipses do not overlap on single conductor lines, lines with bundled conductor shall maintain a minimum distance of the bundle spacing between the ellipses. The following load cases shall be used for galloping calculations:

i. 32°F, 0.5" radial ice, 2 PSF wind for swing angle

ii. 32°F, 0.5" radial ice, 0 PSF wind for sag

K. Phasing.

1. Phasing shall be determined in the field by the Contractor.
2. Phasing shall be placed on the Plan & Profile Drawings as well as the phasing diagram.

1.4 Material

A. General Requirements.

1. Material shall be of new manufacture and unused and be free of defects and irregularities.
2. All assemblies, hardware, and components of assemblies shall be designed to meet the strength requirements of most recent edition of NESC C2.
3. Contractor shall verify that all material, assemblies, hardware, and components of assemblies meet the strength requirements for the application and intended use.
4. Any piece of hardware in an insulator assembly must at a minimum match the ultimate strength of the insulator.
5. Contractor shall be responsible for design of the jumper assemblies such that all electrical clearances are maintained.
6. North American Sourcing Requirement: Steel poles, Hardware, Conductor, and other materials manufactured in North America utilizing North American steel content is required when available. Non-North American components may be approved by Owner on a per project basis for reasons of lead time, suitability, or other project specific requirements.
7. Charpy V-Notch Test

   a. All structural steel plate material furnished shall be mill-certified to meet an impact property of 15 ft. lbs. at -20°F in the longitudinal direction using the Charpy V-Notch Test. This will be on an average of three (3) tests with no one (1) test below 10 ft. lbs. The location of the sample in the test fixture will be as described in ASTM Standard A673. The criterion of 15 ft. lbs. at -20°F is based on full-size test specimens. For sub size specimens, the dimensions and values to be used shall be in accordance with ASTM Standard A673. The Contractor shall guarantee that the Charpy requirement will be met.

b. Insulators and hardware shall be tested for toughness by the Charpy V-Notch method in accordance with ASTM A370 and ASTM E23 and shall provide a minimum energy absorption of 20 Joules at -20°C (CSA C83-17 Charpy Level 1).

8. All insulators shall be toughened glass for all structure types. Polymer post insulators may be used for jumper supports. The maximum allowable load shall not exceed 50% of the insulator's maximum strength rating under the NESC District Loading.

9. Do not apply overload factor to loads when evaluating insulator load cases with a strength reduction factor.

10. End Fittings: Unless otherwise specified, all insulators shall be standard ball and socket type meeting ANSI C 29.1 & C 29.2 (latest edition). Bolt, nut and cotter shall be used for any material with pinned connections.

11. Toughened glass suspension shall be manufactured and tested in accordance with ANSI C29.2B, except that for the Thermal Shock Test as defined in clause 8.2.5 of ANSI C29.2B shall have the low and high temperatures adjusted to -50°F and 122°F, respectively. Additionally, insulator pin material shall be tested for toughness by the Charpy V-Notch method in accordance with ASTM A370 and ASTM E23 and shall provide a minimum energy absorption of 20 Joules at -20°C (CSA C83-17 Charpy Level 1). Annealed glass is not acceptable. Pins shall include a sacrificial zinc sleeve. Austenitic stainless steel cotter keys meeting the requirements of ANSI C29.2B shall be provided with all ball and socket fittings. All toughened glass insulator units shall be clearly marked in accordance with ANSI C29.2B. Additionally, certain units will be further identified with a colored band applied to the cap.

12. Bolt, nut and cotter shall be used for any material with pinned connections. All material shall be of new manufacture, unused, clean and free of defects and irregularities. The designed corona protection should not exceed 0.45 kV/mm anywhere along the insulator string.

13. The type and manufacturer of the insulators shall be consistent (not mixed) across each specific project segment.

14. Insulation Levels

a. The following table lists the insulation levels for each line voltage, in terms of the minimum number of toughened glass bell insulator for each structure type.

	Typical Number of Toughened Glass Bells per String		
Voltage	Tangent & Light Angle (0-10°)	Medium and Heavy Angle (10-60°)	Deadend
115kV	8	10	10
230kV	14	16	16
345kV	Perform Insulation Coordination Study		
500kV	Perform Insulation Coordination Study		

B. Conductor

1. Several conductors, overhead ground wires, and overhead optical ground wires are listed in the tables below. These cables are standard across the Minnesota Power System. Cables for the project shall be selected from the below tables depending on project requirements. Exceptions must be approved by the Owner.

2. Wire, ACSR, Bare: When Aluminum Conductor Steel Reinforced (ACSR) bare conductor is required, the wire shall conform to the mechanical and electrical requirements of ASTM B230, ASTM B232, ASTM B498, ASTM B500, ASTM 606, and the specific properties summarized below:

Wire, ACSR						
Size (kcmil)	Core Type	Stranding (aluminum/ steel)	Code Word	Outside Diameter (inches)	Weight (lbs/ft)	Rated Tensile Strength (lbs)
336.4	GA2	26/7	Linnet	0.72	0.462	14100
636	GA2	24/7	Rook	0.977	0.8182	22600
795	GA2	26/7	Drake	1.108	1.093	31500
954	GA2	54/7	Cardinal	1.196	1.2271	33800
1192.5	GA2	45/7	Bunting	1.302	1.342	32000

1272	GA2	45/7	Bittern	1.345	1.432	34100
1590	GA2	45/7	Lapwing	1.504	1.79	42200

3. Wire, ACSS/TW, Bare: When Aluminum Conductor Steel Supported, Trapezoidal Shaped Aluminum Stands (ACSS/TW) bare conductor is required, the wire shall conform to the mechanical and electrical requirements of ASTM B500, ASTM B609, ASTM B803, ASTM B857, ASTM B958, and the specific properties summarized below:

Wire, ACSS/TW						
Size (kcmil)	Core Type	Stranding (aluminum/ steel)	Code Word	Outside Diameter (inches)	Weight (lbs/ft)	Rated Tensile Strength (lbs)
666.6	MA5	Type 13 20/7	Mystic	0.913	0.855	22900
1033.5	MA3	Type 13 21/7	Curlew	1.129	1.326	30300
1780	MA3	Type 8 37/19	Chukar	1.445	2.06	38200

4. Wire, Overhead Ground, Steel: When galvanized steel or steel OHGW is required, the OHGW shall conform to the mechanical and electrical requirements of ASTM A363, ASTM B6, ASTM A90, and the specific properties summarized below:

Galvanized Steel OHGW					
Type	Stranding	Coating	Outside Diameter (inches)	Weight (lbs/ft)	Rated Tensile Strength (lbs)
3/8”EHS	7 Strand	Class A	0.36	0.273	15400
7/16”EHS	7 Strand	Class B	0.435	0.399	20800
1/2"EHS	7 Strand	Class A	0.495	0.517	26900

5. Wire, Optical Ground: When optical ground wire (OPGW), the OPGW shall conform to the mechanical, electrical, and communication requirements of IEEE 1138, IEC 60794-4, IEC 60793, ITU-T G.65x Series, ANSI/EIA 359-A, ANSI 598-A, IEC 60304, ASTM B483, ASTM B415, and the specific properties summarized below:

Optical Ground Wire					
Type	AFL Spec#	Fiber Count	Outside Diameter (inches)	Weight (lbs/ft)	Rated Tensile Strength (lbs)
AC-64/528	DNO-5651	24	0.528	0.359	18391
AC-77/557	DNO-11204	48	0.557	0.419	22002

C. Vibration Dampers

1. Spiral vibration dampers shall be installed on all OPGW spans per the manufacturer’s recommended spacing.
2. Spiral vibration dampers shall be installed on the overhead ground wire per the manufacturer’s recommended spacing.
3. Stockbridge Type Vibration Dampers shall be installed per the manufacturer’s recommended spacing on all spans of conductor where the vibration analysis indicates dampers are required.

D. Spacer Dampers

1. If conductors are spaced horizontally, spacer-dampers shall be used on conductor bundles at intervals recommended by the manufacturer. Spacer-dampers shall have elastomer bushings, breakaway bolts, and must be rated for the maximum operating temperature.
2. Mid-span spacers are not required for vertically bundled conductors.

E. Conductor Attachment

1. AGS type units shall be used for suspension applications. A second suspension clamp shall be used for deflection angles over 30 degrees.

2. Compression-type terminals appropriately designed for high temperature and EHV application depending on cable type and voltage shall be used for dead-ends and jumpers.

3. All conductor attachment hardware shall meet the maximum conductor operating temperature for the project.

F. Shield Wire and OPGW Attachment

1. AGS type units shall be used for all suspension applications.

2. Bolted strain clamps shall be used for dead-end applications on the OPGW.

3. Compression type terminals shall be used for dead-end applications on the shield wire.

G. Design For Corona (EHV Fittings)

1. For 345 kV and above, corona-free hardware and corona rings shall be used to limit the audible noise to acceptable levels.

2. All armor rods and line guards included with the AGS assemblies on 345 kV and above applications shall have parrot-bill ends.

3. The Interconnection Line, when in operation, shall be corona free and shall not cause radio or television interference, nor excessive noise in excess of requirements set forth in the Applicable Standards, Applicable Permits, or other applicable Requirements.

1.5 Construction

A. Contractor shall prepare, compile, issue, and update a construction specification for the work described in Section 8 of Exhibit 1.

B. Contractor shall procure material and construct the gen-tie line such that, when in operation, does not cause nuisance audible noise or radio or television interference.

C. Contractor shall make all reasonable efforts to minimize all damages due to construction activities.

D. Contractor shall be responsible for preparing and acquiring all crossing permits from the owners of the foreign overhead or underground facilities crossed.

E. Contractor shall be responsible for preparing and acquiring all construction access permits from the state and local agencies with jurisdiction.

F. Contractor shall be responsible for preparing and acquiring all stormwater construction permits.

G. All temporary openings in fences created by the Contractor shall be removed and the fence repaired when access is no longer required. Contractor shall be held responsible for damage to crops, livestock, or other property resulting from failure to keep fences, gates, or fence gaps in proper condition.

H. Contractor shall be responsible for grounding all fences and structures along the gen-tie route.

I. Contractor shall repair and restore the right-of-way and clean up each structure location to the satisfaction of the Owner and the landowner/tenant. All earthwork, culverts, bridges, and drainage structures constructed by the Contractor shall be removed when no longer required.

J. All parts of the structure shall be purchased and installed by the Contractor.

K. Conductor, shield wire, and/or OPGW shall be installed in accordance with “IEEE Guide to the Installation of Overhead Transmission Line Conductors”, Std. No. 524.

L. All conductor cables, shield wire, and OPGW shall be installed by controlled tension methods.

M. Pre-stressing of any type of wire shall not be permitted without the prior written approval of Owner.

N. If conductors are bundled, all conductors in any one bundle shall be sagged simultaneously and all shall be clipped in on the same day. As used here, the “same day” shall be understood to be the same 24-hour period to avoid cables in the same bundle having substantively different creep characteristics.

O. Conductor cables, shield wire, and OPGW shall not be dead-ended and clipped sooner than two (2) hours and should be fully tensioned within 24 hours of initial stringing. In no case shall more than 72 hours elapse between the stringing of conductor/ground wires and their final tensioning.

P. No single conductor cable within a bundle shall be more than one (1) inch from its sag position relative to the other conductor cables.

Q. No more than one (1) splice or repair on any one (1) conductor in any one (1) span shall be made. Splices shall be a minimum of 25 feet from any cable hardware.

R. The exact location where each reel of conductor was installed shall be recorded.

S. Final sag measurements, including but not limited to each sag span’s record date, span number, span length, ruling span, wire temperature, ambient temperature, initial sag for the span, time in blocks, time of day and sag measurements, shall be recorded.

1.6 Submittals

A. Contractor shall prepare the Interconnection Line design documents per The Submittal Schedule and containing the following information, at a minimum: (a) design basis; (b) plan and profile drawings, including electrical phasing matching the phasing at the Project Substation terminations with minimal rolls and phase swapping; (c) structure details and drawings, including elevations, spacing, and hardware; (d) civil works drawings, including subgrade preparation, grading, drainage, and erosion control; (e) foundation design and embedment drawings; (f) anchoring and guying details; (g) structural calculations; (h) PLS-CADD design files, including .BAK and .KMZ files; (i) grounding details; (j) drawing index; (k) bill of materials; and (l) inspection testing, and quality control requirements.

B. Contractor shall prepare equipment specifications to define the requirements and properties for the procurement of all permanently installed Interconnection Line equipment and materials. The specifications shall be submitted to Owner for review prior to the procurement of the applicable equipment. The following specifications shall be provided, each as applicable to the design: (a) construction specification; (b) structures; (c) conductor; and (d) OPGW.

C. Contractor shall submit manufacturer's approval drawings or product sheets (material cut sheets) for all permanently installed Interconnection Line equipment and materials, including all items identified in Section 7.2.2 above.

D. Contractor shall prepare energization plans and procedures for the Interconnection Line. Energization plans shall be submitted to Owner for approval prior to use. Energization plans shall include both electrical and communications infrastructure as well as backfeed plans, soaking plans, testing plans, and lock out tag out procedures, at a minimum.

8.0 COMMUNICATIONS SYSTEM

8.1 General Provisions

8.1.1 **The Communications System shall be designed with data continuity and reliability as priority.**

8.1.2 **All monitoring and control devices and systems shall be suitably zone protected against lightning electromagnetic impulses in accordance with IEEE C37.90.1.**

8.1.3 **The Communications System shall be compliant with all Applicable Standards, including NERC Functional Model Registered Entity function, NERC Reliability Standards, Regional Entity Standards, approved regional variances, and/or FERC Orders. Further, the Communications System shall comply and be designed to work in accordance with applicable system operator approved protocols, operating guides, standards, business practice manuals, and/or approved rules. In so far as either a state utility commission or provincial authority has instituted additional regulations, the communications system should be designed to accommodate where no conflict exists with NERC or FERC. Design should include parameters for operating under conditions specified by rules stated hereto as well as capability to function on an evidentiary basis.**

8.1.4 **All Communications System design and construction shall conform to Turbine Supplier's requirements as set forth in Exhibit [●] (*Exhibit Name*).**

8.1.5 **Requirements for system functionality:**

(1) The Communications System shall be capable of centrally and remotely monitoring, controlling, and recording the performance of the Project Substation equipment, permanent meteorological towers, and other critical sensors.

(2) The Communications System design shall include configuration files and a comprehensive data points list and protocol specification for communications between all Project components requiring communications, data transfer, and control monitoring using the fiber network integrated into the Communications System. Such configuration files shall have the ability to be configured by Owner, and Contractor shall furnish development application software for each configurable device.

(3) The Communications System shall include the necessary equipment (hardware and software) for the exchange of signals with and integration of (a) Project Substation equipment to support grid monitoring; (b) any required reactive compensation devices (e.g., capacitor banks, reactors); (c) the permanent meteorological towers to support data monitoring; and (d) Wind Turbine and meteorological tower FAA lights.

(4) Upon loss of utility power interconnection or failure of utility power, restart of the instrumentation and control system to a fully-functioning condition should require no local manual operations. Synchronization shall be performed automatically.

8.1.6 **Requirements for fiber network:**

(1) See Section 5.1.13 for fiber optic cabling requirements.

8.1.7 **Requirements for monitoring and control:**

(1) Design and installation of the Communications System shall be provided with all hardware, telemetry, communication and other requirements as required by the interconnection utility.

(2) The Communications System shall be provided with the following supervisory screens, at a minimum.

(a) Project Substation one-line diagram, including all breakers, switches and transformers and the real-time status of each (current, power, voltage, power factor, and reactive power, as applicable).

(b) Project Substation alarms and notifications: (1) status of all relays and (2) status of all alarms and notifications.

(c) Main power transformer status, including the following for each main power transformer: (1) operation and fault status, including alarms; (2) relay statuses; (3) temperatures (winding, oil); and (4) tap changer position.

(d) Breaker status, including the following for each medium- and high-voltage breaker: (1) operation and fault status, including alarms; (2) relay statuses; and (3) breaker readings (current, power, voltage), including per Collection System Circuit.

(e) Control building status, including the following: (1) operation and fault status, including alarms; (2) enclosure alarms (fire/smoke alarm status, enclosure temperature, intrusion, etc.); (3) battery charger voltage and status; (4) intrusion detection; and (5) HVAC status.

(f) Not used.

(3) Other supervisory screen requirements:

(a) All major components (e.g., breakers, transformers, meteorological towers) shall be listed separately.

(b) Alarms and faults shall be color-coded where applicable (e.g., green, yellow, red).

(4) The Communications System shall include control functionality for the following, at a minimum: (a) active power; (b) reactive power; (c) frequency; (d) voltage; (e) power factor; and (f) noise-related operations.

(5) Fault notification shall be provided through real-time text messaging or e-mail alerts, as determined by Owner. Fault notification messages and recipients shall be specified by Owner.

8.1.8 **Requirements for reporting and storage:**

(1) All reporting shall be in Generation Availability Data System ("**GADS**"), wind format.

(2) SCADA system reporting shall include, at a minimum, the following for the Project Substation, and permanent meteorological towers: (a) performance parameters, availability, operation counters, faults, and alarms; (b) browsing and filtering of historical data; and (c) creation of pre-defined and custom reports.

(3) All data monitored by the Communications System shall be recorded and stored. Local controllers shall have sufficient buffer for at least 30 days of data storage in the event of power loss.

(4) Historical data shall be stored in an SQL database or Owner-approved equivalent for the life of the Project. Data shall be stored in the database as no higher than 1-minute averages, with accompanying statistical values including, but not limited to, minima, maxima, and standard deviation. All data shall be retrievable.

(5) All stored data and generated reports shall be exportable as ASCII and Microsoft Excel formats.

(6) The system shall not permit unwarranted tampering with or changing of raw data or functionality.

8.1.9 **Power Plant Controller: The Power Plant Controller shall be able to accept commands from the following locations and distribute these commands to all equipment on Site as necessary:**

(1) Local operator station

(2) Owner's centralized remote command center

(3) Utility or ISO dispatch commands (such as Automated Dispatch System in CAISO) .

(4) At a minimum, the following controls capabilities shall be available at the plant level:

(a) Power factor control

(b) Reactive power (VAR) control

(c) Output power curtailment

(d) Power and VAR ramp rate adjustment

(e) Frequency droop control (freq vs. kW)

(f) Automatic voltage regulation (AVR) at the point of interconnection (POI) utilizing reactive power (VAR) control

(5) Power Plant controller shall utilize a Computer Server, PLC, SEL-3530 RTAC or similar quality controller.

8.2 Submittals

8.2.1 **Contractor shall prepare configuration files and a comprehensive data points list and protocol specification for communications, as more particularly described in Section 8.1.5 herein. The points list shall include all required points for the Turbine Supplier, interconnection utility, and offtaker(s) as required.**

8.2.2 **Refer to Section 5.2.1 and Section 6.2.1 for additional Communications System submittals.**

8.2.3 **Contractor shall submit manufacturer's approval drawings or product sheets (material cut sheets) for all permanently-installed equipment and materials.**

8.3 Communications System

8.3.1 **Contractor shall design, furnish, construct, and install the Communications System in conformance with the minimum requirements set forth herein and the [preliminary] design documents in Exhibit [●] (*Design Documents Exhibit Name*).**

(1) Contractor shall furnish all labor, equipment, and materials that are necessary for a complete, fully-functional, and safe Communications System configuration.

(2) Contractor shall furnish and install all network and communication devices, including programming and configuration, necessary for the Communications System.

(3) Contractor shall provide an open-process control ("**OPC**") interface for communication with Owner's OSI PI historian.

(4) Contractor shall furnish and install / terminate all fiber optic cabling between the Wind Turbines (subject to the responsibility for fiber terminations in the base of each Wind Turbine as described in Section 5.3.4 herein), Project Substation, permanent meteorological towers, and O&M Building, including patch cables between fiber patch panels and devices.

(5) Contractor shall develop and furnish HMI supervisory screens for the Project Substation RTAC as described in Section 8.1 herein.

(6) Contractor shall furnish and configure the RTAC, including incorporation of the Turbine SCADA System (i.e., Vestas VOB, WindSCADA) and dissemination of points to the interconnection utility and offtaker, as requested.

8.3.2 **Contractor shall install the Turbine SCADA System, including all power and fiber optic terminations, within the O&M Building or Substation Control Building.**

8.4 Contractor Testing and Quality Control

8.4.1 **Contractor shall test, commission, start-up, and place into successful operation the Communications System, including the electrical infrastructure and communications infrastructure. At a minimum, testing shall be in conformance with the following minimum requirements. All testing shall be performed by an independent, experienced third party.**

(1) All Communications System equipment shall be tested to demonstrate it meets stated design criteria and is fit for purpose.

(2) All testing specified in the Applicable Standards, including NETA.

(3) All testing reasonably recommended or required by the applicable equipment suppliers.

(4) All exposed cable sections shall be visually inspected for physical damage or manufacturing defects. Such inspections shall be performed prior to and during installation.

(5) Verify all alarms, indications and analog quantities are communicated and received properly by the RTU and displayed correctly on the HMI.

(6) Verify all communication channels (intra- and inter-Project Substation), including Project Substation LAN, operate as expected.

(7) Verify fiber optic system performance (power losses, splice or connector losses, etc.) using OTDR. All such testing shall be done with an OTDR in both directions of the strands. For single-mode fiber, test both directions at 1310 nm and 1550 nm. A successful test result shall be (a) less than 0.35 dB per connection and (b) (i) less than -50 dB if UPC and (ii) less than -65 dB if APC.

(8) All fiber optic cable shall be visually inspected and OTDR-tested prior to installation / termination.

(9) Provide system functionality and compatibility at the control room / O&M Building.

(10) Test each cable and strand on every fiber run from termination to termination.

(11) Provide entire Project Site testing to ensure proper operation of all data points into the component gateways and testing of all data points provided to third parties with that party.

(12) Other testing set forth in the [preliminary] design documents in Exhibit [●] (*Design Documents Exhibit Name*).

8.4.2 **Contractor shall notify Owner of all testing schedules at least 30 days in advance of testing activities and copies of testing reports (including a summary of testing procedures and acceptance criteria) shall be submitted to Owner within 10 days of completing such test.**

9.0 INTERCONNECTION SUBSTATION / SWITCHYARD

Not used.

10.0 WIND TURBINE INSTALLATION AND TECHNICAL REQUIREMENTS

10.1 General Provisions

10.1.1 **Contractor's proposal shall include Wind Turbine Original Equipment Manufacturer, Wind Turbine model, and Technical Specifications for the Wind Turbines provided. The technical specifications shall include at minimum: hub height, rotor diameter, nameplate capacity ambient temperature operating limits, and turbine blade ice prevention/mitigation features.**

10.1.2 **Contractor shall meet with Owner and Turbine Supplier prior to installation of the first Wind Turbine to participate in an in-person page turn of the Wind Turbine installation manual.**

10.1.3 **Contractor shall clean and wash all external Wind Turbine surfaces prior to erection to remove dirt generated by delivery and on-site storage. All exterior Wind Turbine surfaces shall be cleaned via pressure washing; light brushing with mild, biodegradable detergent shall be performed as necessary. Following cleaning, all surfaces shall appear clean at a minimum distance of 50 feet. All washing, including runoff, shall be in accordance with the Applicable Permits and other Requirements.**

10.1.4 **Wind Turbine erection shall follow a "reference" approach, wherein complete erection of the first Wind Turbine shall occur prior to erecting any subsequent Wind Turbines. Such initial Wind Turbine erection shall be reviewed and approved by Owner and Turbine Supplier before continuing Wind Turbine erection activities, and such approval shall not be unreasonably withheld or delayed. The "reference" Wind Turbine, once accepted, shall serve as a model finished product for all subsequent Wind Turbine erections.**

10.1.5 **Wind days shall be actively minimized by scheduling Wind Turbine erection activities at times of day when wind speeds are projected to be lowest.**

10.1.6 **Wind Turbines shall be erected such that the tower door orientation is downwind of the of the prevailing wind direction.**

10.1.7 **Each crane, including the main erection crane(s) and any base/mid crane(s), shall be equipped with redundant anemometers at Wind Turbine hub height for measurement of wind speeds. Wind speeds shall be recorded from these instruments prior to the start of all lifting activities, and measurements shall be recorded on a Contractor-furnished data logger. Handheld anemometers shall also be furnished to determine safe wind speeds for all other operations. All such wind data shall be shared with Owner upon request.**

10.1.8 **Transportation, offloading, storage, and erection of Wind Turbines shall be performed in accordance with the applicable instructions provided by Turbine Supplier in Exhibit [●] (*Exhibit Name*) and the specifications provided herein, including critical lift plans.**

10.1.9 **Mechanical completion of each Wind Turbine, including documentation of progress on Turbine Supplier-furnished forms, shall be successfully achieved in accordance with the instructions set forth in the installation manual and mechanical completion checklists provided by Turbine Supplier.**

10.1.10 **All rigging utilized for the transportation, offloading, or erection of Wind Turbines shall be rated; inspected daily; and load tested in accordance with Applicable Standards or other more rigorous requirements set forth in the HSSE Plan. Inspection reports shall be maintained at the Project Site and available for review by Owner.**

10.1.11 **Copies of testing certificates and calibration records for all tooling shall be maintained at the Project Site and available for review by Owner.**

10.2 Wind Turbine Required Features

(1) Cold Weather Package which allows turbine operation to -30 degrees Celsius or colder. Provide available options for turbine blade icing prevention/mitigation.

(2) Service lift or powered electric platform for personnel ascent.

(3) Central automatic lubrication systems allowing for annual maintenance/refilling intervals for critical turbine components. These units shall be pump-driven, capable of mixing grease to prevent separation, and integrated into the condition-based monitoring system for alarm notifications. All components of the system shall be resistant to oil and grease, rated for climatic conditions and installed in locations clear of walkways and maintenance points. Grease catch devices must be provided to prevent uncontrolled grease purging.

(4) Condition-based monitoring system. This system shall include all sensors, servers, software, and remote monitoring support to provide continuous monitoring of critical turbine components as per standard industry best practices.

10.3 Wind Turbine Deliveries

10.3.1 **Contractor shall coordinate with Turbine Supplier on a test run for Wind Turbine deliveries at the Project Site by use of non-loaded trucks to demonstrate that road dimensions will be appropriate for successfully delivering components to the Wind Turbine Pads. Such trial run will be performed by Turbine Supplier prior to commencing deliveries of Wind Turbine equipment to the Project Site. Any non-compliant areas shall be immediately corrected by Contractor.**

10.3.2 **Contractor shall furnish and operate assist vehicles as necessary for delivery and movement of Wind Turbines at and within the Project Site.**

10.3.3 **Contractor shall receive, visually inspect, and inventory all deliveries of Wind Turbine equipment (including Wind Turbines, transformers, down-tower converters, switchgear, service lifts, Turbine SCADA System, Special Tools, and shipping containers) to the Project Site. Contractor shall submit reports to Owner within 24 hours of delivery regarding receipt, inspection, and inventorying of all such deliveries, including any damage identified.**

10.3.4 **Contractor shall offload all Wind Turbines at the Project Site. Contractor shall offload and stage all Wind Turbine deliveries at the Wind Turbine Pad location nearest each Wind Turbine, subject to the offloading schedule requirements set forth below.**

(1) Subject to the offloading limitations that follow, (i) if a Delivery Truck arrives by 2:00 p.m. at the Delivery Point on a Delivery Day, Contractor shall offload such vehicle before 6:00 p.m. on the same day; and (ii) if a Delivery Truck arrives on a day that is not a Delivery Day or after 2:00 p.m. on a Delivery Day, Contractor shall offload such vehicle before 6:00 p.m. on the next Delivery Day. Contractor shall not be obligated to (a) offload more than [twenty (20)] Delivery Trucks in any single Delivery Day or (b) offload Delivery Trucks at more than [three (3)] separate Wind Turbine Pad locations in any single Delivery Day. Notwithstanding the foregoing, Contractor shall use commercially reasonable efforts to offload additional Delivery Trucks that may arrive at a Delivery Point in excess of these quantities. For purposes of this exhibit, a "**Delivery Day**" shall be understood to mean a Monday through Friday that is also a Business Day, between the hours of 7:00 a.m. and 5:00 p.m. local time; the "**Delivery Point**" shall be understood to mean the Wind Turbine Pad location nearest each Wind Turbine; and a "**Delivery Truck**" shall be understood to mean a delivery vehicle carrying Wind Turbine equipment.

10.3.5 **Contractor shall furnish and maintain protective tarps to eliminate unwanted materials from entering Wind Turbine equipment after removal of shrink wrapping.**

10.3.6 **Contractor shall furnish and install adequate measures to prevent Wind Turbine equipment from being blown over or otherwise damaged while stored at the Project Site. This shall include tie down of blades and other similar measures.**

10.4 Wind Turbine Installation

10.4.1 **Contractor shall apply touch-up paint as necessary to repair any damage to Wind Turbine equipment, including damage that occurred prior to or during Wind Turbine erection.**

10.4.2 **Contractor shall assemble, install, construct, and erect all Wind Turbines, including all components, equipment, down-tower converter assemblies, stairs, service lifts, and other similar items, and including furnishing of the main crane(s) with suitable capacity for Wind Turbine erection.**

(1) Contractor shall furnish all labor, equipment (including rigging, tooling, hoisting equipment, and lifting devices), and materials that are necessary to assemble and install the Wind Turbines, excluding only the Owner-Supplied Equipment in Exhibit [●] (*Owner-Supplied Equipment*).

(2) Contractor shall fabricate and furnish all anchor bolt template rings as required to support Wind Turbine installation.

(3) Contractor shall design, furnish, construct, and install concrete slabs for the stair support columns and concrete stair landing for each Wind Turbine.

(4) Contractor shall grout, install, shim, and level all tower base sections, including providing all necessary grease, shim packs, leveling feet, and other necessary items or consumables.

(5) Contractor shall provide all crane breakdowns, both partial and full, necessary to complete the Work.

(6) Not used.

10.4.3 **Contractor shall install the electrical wiring and cabling in each Wind Turbine, including all necessary pulling, dressing, lugging, taping, splicing, and terminations, to interface to the Turbine Foundation.**

(1) Contractor shall furnish all labor, equipment, and materials that are necessary for the electrical connection of the Wind Turbines to the Collection System Circuits, including all down-tower cabling and the following clarifications:

(a) All cabling and connectors on the Wind Turbine-side of the down-tower converter assembly shall be furnished by Turbine Supplier.

(b) All cabling and connectors on the grid-side of the down-tower converter assembly shall be furnished and installed by Contractor.

(2) Contractor shall install the grounding system in each Wind Turbine, including grounding of Wind Turbine stairs.

(3) Contractor shall furnish and install (a) all temporary Turbine obstruction lights, including wiring and mounting brackets and (b) [QUANTITY] permanent Turbine obstruction lights, including wiring and mounting brackets. Obstruction lights shall be (i) FAA Type L-810 (red, steady burning), L-864 (red, flashing), or L-865 (white, flashing, medium intensity) as determined in Owner's *Determination of No Hazard to Air Navigation* letter from the FAA; (ii) in compliance with the Requirements, including US DOT-FAA Advisory Circular No. AC 70/7460-1K: *Obstruction Marking and Lighting*; (iii) provided with an uninterruptible power supply capable of supplying back-up power for at least one (1) hour; (iv) programmed to blink in unison, including with those aviation obstruction lights that are installed on meteorological towers; and (v) night vision goggle compliant. Contractor shall remove all temporary FAA lights when no longer needed. [RFP Clarification: Quantity to be updated for Project site and FAA approval.]

10.4.4 **Not used.**

10.4.5 **Contractor shall successfully achieve Wind Turbine Mechanical Completion of each Wind Turbine, including documentation of progress on Turbine Supplier-supplied forms for each Wind Turbine, in accordance with the applicable instructions set forth in the installation manual and mechanical completion checklists in Exhibit [●] (*Installation Manual / MCC Checklists Exhibit Name*).**

10.4.6 **Contractor shall provide a final broom cleaning of each Wind Turbine prior to handoff following Wind Turbine Mechanical Completion. Further, each Wind Turbine should be reasonably clean and free from grease, oil, and other grime prior to Wind Turbine Mechanical Completion.**

10.4.7 **Contractor shall collect and repackage all returnable items on loan from Turbine Supplier, including, but not limited to, shipping frames, delivery devices, brackets, lifting and rigging equipment, specialized tooling, and other returnable items. Contractor shall repackage all such items inside emptied parts containers per instructions provided by Turbine Supplier and shall provide inventory tracking and packing lists for such repackaged items. Contractor shall load all such repackaged items on transport trucks as made available by Turbine Supplier at the Project Site per the schedule set forth in the Agreement. Contractor shall be responsible for moving all such items from the Wind Turbine Pads to the designated loading area(s) for transport as necessary.**

10.4.8 **Contractor shall provide qualified personnel to perform lock-out / tag-out, switching, and other similar activities during the commissioning of the Wind Turbines by Turbine Supplier up until Contractor's Substantial Completion.**

10.5 Coordination

10.5.1 **Contractor shall actively coordinate the sequence of Work with Owner and Owner's Contractors (including Turbine Supplier) to support the Project Schedule.**

10.5.2 **Contractor shall coordinate with Turbine Supplier on the handoff following Wind Turbine Mechanical Completion. At a minimum, such coordination shall ensure that Turbine Supplier is aware that the respective Wind Turbine has successfully completed mechanical completion so that Turbine Supplier may commence inspection and commissioning activities. Additionally, Contractor shall share reasonable information with Turbine Supplier and turn over Wind Turbine access to Turbine Supplier as part of this coordination.**

10.5.3 **Contractor shall attend and actively participate in all Wind Turbine Mechanical Completion walk-downs with Turbine Supplier.**

10.5.4 **Contractor shall provide qualified support personnel to perform all lock-out-tag-out, switching, startup and testing activities in connection with Turbine Supplier's commissioning, start-up and testing of the Wind Turbines.**

10.5.5 **Contractor shall coordinate with Turbine Supplier on any termination of power or fiber optic cabling in Wind Turbines following Wind Turbine Mechanical Completion.**

10.5.6 **Contractor shall coordinate with Owner's meteorological tower consultant on the installation of the meteorological towers and the termination of cabling during installation.**

10.6 Testing and Quality Control

10.6.1 **Contractor shall test the Wind Turbine tower electrical wiring and cabling. At a minimum, testing shall include the minimum requirements set forth below. All testing shall be performed by an independent, experienced third party.**

(1) All Wind Turbine electrical wiring shall be tested to demonstrate it meets stated design criteria and is fit for purpose.

(2) All testing specified in the Applicable Standards, including NETA.

(3) All testing reasonably recommended or required by the applicable equipment suppliers.

(4) Structural works testing for grout properties, in accordance with <u>Section 4.1.11</u> herein.

(5) Visual inspection, insulation resistance testing, and continuity testing of the Turbine cabling as described in <u>Section 5.4.1</u> herein.

(6) Other testing set forth in the [preliminary] design documents in Exhibit [●] (*Design Documents Exhibit Name*).

10.6.2 **Contractor shall notify Owner of all testing schedules at least 30 days in advance of testing activities and copies of testing reports (including a summary of testing procedures and acceptance criteria) shall be submitted to Owner within 10 days of completing such test.**

11.0 METEOROLOGICAL TOWERS

11.1 General Provisions

11.1.1 **References to “meteorological towers” herein shall be understood to include the permanent meteorological tower(s), unless explicitly stated otherwise.**

11.1.2 **Meteorological towers shall be sized and constructed appropriately to allow instrumentation to be placed at Wind Turbine hub height. A side-by-side (i.e., goalpost) anemometer orientation, as shown in IEC 61400-12-1, shall be utilized; such side-by-side anemometers will be mounted at Wind Turbine hub height on each permanent meteorological tower.**

11.1.3 **Meteorological towers shall be designed and fabricated to the latest EIA/TIA-222-FS Structural Standards for Steel Antenna Towers and Antenna Supporting Structures and according to other Applicable Standards.**

11.1.4 **Meteorological tower designs, including foundation design, shall be approved by Owner prior to procurement of such equipment or materials.**

11.1.5 **All meteorological towers shall incorporate a safety climb cable.**

11.1.6 **Sufficient grounding and lightning protection per IEC 61400-12 shall be installed on all meteorological towers, including lightning finials. Meteorological towers shall be independently grounded; meteorological tower grounding shall not be interconnected to the Wind Turbine grounding system.**

11.1.7 **All anemometers shall be type “first class”, heated sensors. All anemometers shall be calibrated in accordance with MEASNET’s Anemometer Calibration Procedure and performed by a MEASNET-certified organization.**

11.1.8 **Instrumentation booms shall be oriented to minimize tower shading (e.g., perpendicular to prevailing wind direction).**

11.1.9 **Requirements for meteorological tower civil and structural works:**

(1) All civil works for the meteorological towers shall comply with the applicable specifications in Section 4.0 *(Civil / Structural Works*).

(2) All meteorological tower structures, foundations, assemblies, and components shall be designed and constructed in accordance with the applicable structural works specifications in Section 4.1 herein.

11.1.10 **Requirements for meteorological tower marking and lighting:**

(1) Meteorological towers shall be galvanized.

(2) Meteorological towers shall be marked in accordance with the Requirements.

(3) All meteorological towers shall be provided with aviation obstruction lights, including top- and mid-level as required, and including all mounting assemblies, GPS controller, and photocell as required by the Federal Aviation Administration and all other Applicable Standards. Obstruction lights shall be (a) FAA Type L-810 (red, steady burning), L-864 (red, flashing), or L-865 (white, flashing, medium intensity) as determined in Owner's *Determination of No Hazard to Air Navigation* letter from the FAA; (b) in compliance with the Requirements, including US DOT-FAA Advisory Circular No. AC 70/7460-1K: *Obstruction Marking and Lighting*; (c) provided with an uninterruptible power supply capable of supplying back-up power for at least one (1) hour; and (d) programmed to blink in unison, including with those aviation obstruction lights that are installed on the Turbines. Contractor shall remove all temporary FAA lights when no longer needed.

11.1.11 **Requirements for communications:**

(1) All permanent meteorological towers shall be connected to, and communicate with, the Communications System and allow data recording and storage through the data archival features of the Communications System.

(2) Communication from each permanent meteorological tower to the Communications System shall be via dedicated fiber optic circuit. Such communication path shall follow the same route as the Collection System Circuits in order to minimize disturbed area.

11.1.12 **Requirements for power:**

(1) Permanent power supply for each permanent meteorological tower shall be taken from the nearest Wind Turbine or Collection System Circuit. Such permanent power supply path shall follow the same route as the Collection System Circuits in order to minimize disturbed area.

11.2 Submittals

11.2.1 **Contractor shall prepare the meteorological tower design documents per The Submittal Schedule and containing the following information, at a minimum: (a) design basis; (b) foundation plans and details, including all structural calculations, pier details, and footing details; (c) tower details, including boom elevations, boom directions, equipment mounting, guying details, and hardware details; (d) instrument details, including all equipment listed herein; (e) wiring schematics; (f) H-frame diagrams; (g) grounding details; (h) power supply details; (i) fiber termination diagrams; (j) drawing index; (k) bill of materials; and (l) inspection, testing, and quality control requirements.**

11.2.2 **Contractor shall submit manufacturer's approval drawings or product sheets (material cut sheets) for all permanently-installed equipment and materials.**

11.3 Power Curve Test Site Calibration Requirements

11.3.1 **The overall site design must be capable of power performance testing in accordance with the turbine OEM requirements.**

11.4 Existing Meteorological Towers

11.4.1 **Contractor shall decommission the [QUANTITY] existing, temporary meteorological towers at the Project Site. All equipment from these existing towers shall be stored at an Owner-designated location at the Project Site.**

11.5 Permanent Meteorological Towers

11.5.1 **Contractor shall design, furnish, construct, and install one (1) permanent meteorological tower for every 100 MW of nameplate capacity.**

(1) Contractor shall furnish all labor, equipment, and materials that are necessary for a complete, fully-functional, and safe permanent meteorological tower configuration.

(2) Permanent meteorological towers shall be installed at the location shown on Exhibit [●] (*Project Site Plan Exhibit Name*).

(3) Permanent meteorological towers shall be [HUB HEIGHT]-meter, self-supported (non-guyed), galvanized lattice structures, each designed and certified for maximum wind and ice loading for the Project Site conditions.

11.5.2 **Contractor shall furnish and install fencing and gates at each permanent meteorological tower.**

(1) Fencing shall be placed to allow a minimum of 10 feet of free space around the tower base and shall have constructed dimensions of approximately 40 feet by 40 feet. Fencing shall be grounded.

(2) At least one (1) gate shall be installed at each permanent meteorological tower. The gate shall be a lockable swing-gate, sufficiently wide for light-duty vehicle access.

(3) All fencing and gates shall comply with the minimum specifications in Section 4.1.8 herein.

(4) The fenced area for the permanent meteorological tower shall be covered throughout with at least six (6) inches of aggregate over a compacted subgrade, with aggregate extending at least one (1) foot beyond the fence in all directions and using the same aggregate material as the access roads.

11.5.3 **Contractor shall furnish and install a 12-foot-wide road to each permanent meteorological tower. Such roads shall be constructed of the same materials and with the same cross section as the primary access roads.**

11.5.4 **Each permanent meteorological tower shall include the following instruments:**

(1) Two (2) cup anemometers at Wind Turbine hub height in a goal-post configuration.

(2) (*) One (1) cup anemometer at mid-blade height.

(3) One (1) cup anemometer at lower-blade height.

(4) (*) One (1) vertical anemometer near Wind Turbine hub height (below goal post).

(5) (* … only 1 vane needed) Two (2) wind direction sensors near Wind Turbine hub height (below goal post). Each shall be MetOne 020C and NRG #200P, respectively.

(6) (*) One (1) temperature / relative humidity sensor with radiation shields near Wind Turbine hub height (below goal post). Each shall be MetOne 597 or Vaisala HMP60A.

(7) (*) One (1) barometric pressure sensor near Wind Turbine hub height (below goal post). Each shall be MetOne 092 or Vaisala PTB 110.

(8) One (1) temperature / relative humidity sensor with radiation shields at 10 meters above ground level. Each shall be MetOne 597 or Vaisala HMP60A.

(9) (*) One (1) precipitation sensor. Each shall be Campbell Scientific 237-L.

11.5.5 **Each permanent meteorological tower shall include the following auxiliary equipment:**

(1) One (1) NEMA 4X fiberglass enclosure for data logger and auxiliary equipment.

(2) One (1) data logger. Each shall be Campbell Scientific, model CR1000.

(3) (*) One (1) [satellite / cellular] data modem.

(4) One (1) radio. Each shall be Campbell Scientific, model 401A.

(5) Signal surge protection terminals. Each shall be Phoenix Contact, type Termitrab 24V.

11.5.6 **Each permanent meteorological tower shall include the following other equipment:**

(1) Two (2) obstruction lights, including top- and mid-level, and including mounting brackets. The top-level light shall be mounted below the goal post.

(2) Grounding and lightning protection, including lightning finial.

(3) Instrumentation booms.

(4) Cabling.

(5) H-frame equipment rack.

(6) Fiber patch panel.

(7) Step-up transformer.

(8) Safety climb cable.

(9) (*) Temporary power supply for data logger and aviation lights.

11.6 Not used.

11.7 Testing and Quality Control

11.7.1 **Contractor shall test, commission, start-up, and place into successful operation the meteorological towers. At a minimum, testing shall include the minimum requirements below. All testing shall be performed by an independent, experienced third party.**

(1) All meteorological tower equipment shall be tested to demonstrate it meets stated design criteria and is fit for purpose.

(2) All testing specified in the Applicable Standards.

(3) All testing reasonably recommended or required by the applicable equipment suppliers.

(4) Meteorological tower foundations shall be tested for concrete strength and properties, including break tests, grout cubes, slump, air, and temperature, each at the minimum frequencies specified in Section 4.1.10 and Section 4.1.11 herein.

(5) All exposed cable sections shall be visually inspected for physical damage or manufacturing defects. Such inspections shall be performed prior to and during installation.

(6) Resistance testing on grounding grid at each tower location.

(7) Final continuity tests after completion of all system connections. Acceptable continuity tests shall include a Megger test or VLF test at 100 percent of rated voltage.

(8) Verify all alarms, indications and analog quantities are communicated and received properly by the RTU and displayed correctly on the HMI.

(9) Verify all communication channels operate as expected.

(10) Other testing set forth in the [preliminary] design documents in Exhibit [●] (*Design Documents Exhibit Name*).

11.7.2 **Contractor shall notify Owner of all testing schedules at least 30 days in advance of testing activities and copies of testing reports (including a summary of testing procedures and acceptance criteria) shall be submitted to Owner within 10 days of completing such test.**

12.0 O&M BUILDING

12.1 General Provisions

12.1.1 **Requirements for O&M Building configuration:**

(1) The O&M Building shall be a single-story building totaling approximately 5000 to 6000 square feet of usable space.

(2) The O&M Building shall be designed and constructed such that it is ADA compliant, including parking, doorways, bathrooms, and other building features.

(3) The O&M Building shall comply with all Turbine Supplier requirements for the building, including office quantity, furnishings, warehouse requirements, and other similar items as set forth in Exhibit [●] (*Exhibit Name*).

(4) The O&M Building shall contain at a minimum, three offices for use by Contractor administrative personnel.

(5) All manufacturer installation instructions for the installation of all O&M Building equipment and components shall be obtained and followed.

(6) The O&M Building shall be constructed using metal studs.

12.1.2 **Requirements for O&M Building civil works:**

(1) All civil works for the O&M Building shall comply with the applicable specifications in Section 4.0 *(Civil / Structural Works*).

(2) Excavated material shall be backfilled and compacted on the outside of the foundation walls adjacent to green areas and graded around building to provide proper drainage. The outside foundation walls adjacent to hard surfaces and future additions shall be filled with compacted granular fill.

(3) Fill shall be compacted to at least 95 percent (97%) of the maximum density within the moisture content of two percent (2%) below optimum to two percent (2%) above optimum, as determined by ASTM Standard D698, unless a higher level of compaction is required by the Geotechnical Report. Contractor shall furnish compaction-testing results to Owner.

(4) The fenced area for the O&M Building shall be covered throughout with at least six (6) inches of aggregate over a compacted subgrade, including geotextile fabric (or equivalent) as required with aggregate extending at least one (1) foot beyond the fence in all directions. The maximum aggregate size shall not exceed two (2) inches.

12.1.3 **Requirements for O&M Building structural works:**

(1) All O&M Building structures, foundations, assemblies, and components shall be designed and constructed in accordance with the applicable structural works specifications in Section 4.1.

(2) The O&M Building shall have a reinforced-concrete foundation covering the building footprint. The O&M Building floor shall be at least six (6) inches thick. Where necessary, the floor shall be thickened to accommodate large equipment (e.g., generator) and heavy loads to be stored in that area.

(3) Minimum concrete strength shall be 4,000 psi for footings and walls, respectively, and 4,000 psi for floors in place in 28 days.

(4) Welded wire fabric shall conform to ASTM A185. Plain wire shall conform to ASTM A82. Placement shall be in accordance with Chapters 7 and 12 of ACI 318 and the CRSI's "*Manual of Standard Practice*".

(5) All foundations shall extend a minimum of six (6) inches above the adjacent finished grade.

(6) Concrete for equipment pads and containment areas shall be sealed with petroleum resistant sealant. All exposed concrete slabs, interior or exterior, shall have a combination sealer/curing compound, ASTM C309 or equivalent applied.

(7) Footing, wall, and floor heights shall be set with a laser transit to improve accuracy of determining heights for construction.

(8) Design of structural and miscellaneous steel shall be in accordance with the AISC's "*Manual of Steel Construction*". Design of structural and miscellaneous steel shall also be in accordance with NEMA Standard SG6, NEMA Standard TT1, and the International Code Council's "*International Building Code*", respectively.

(9) High strength bolts, nuts, and washers shall be galvanized in accordance with ASTM F2329. Bolts, nuts, and washers under 0.5 inches in diameter shall conform to ASTM A307, Grade B, ASTM A563 and ASTM F844 respectively, and shall be galvanized in accordance with ASTM F2329.

(10) Anchor bolts, anchor bolt assemblies, and concrete embedments shall be galvanized. Galvanizing shall conform to the requirements of ASTM A123, ASTM A153 or ASTM A2329 as applicable.

(11) Anchor bolts shall conform to ASTM A449, ASTM F1554, Grade 36 or A307. Anchor bolt sleeves shall conform to ASTM A501.

(12) All structural welding shall conform to the requirements of AWS Standard D1.1.

(13) Stainless steel shall conform to ASTM A167.

(14) Design of structural and miscellaneous aluminum shall be in accordance with the latest version of the Aluminum Association's "*Aluminum Design Manual*" and "*Aluminum Standards and Data*".

(15) Materials for structural and miscellaneous aluminum including structural shapes and plates shall conform to ASTM B209 and ASTM B308 and shall be aluminum alloy 6061-T6.

(16) Bolts and nuts shall conform to ASTM F468 and ASTM F467, respectively, and shall be aluminum alloy 6061-T6. Washers shall be aluminum-clad steel Alclad 2024-T4 or approved equal.

(17) Vapor retarder: 10 mil polyethylene placed under office floor and anywhere floor finish or coating shall be used to help reduce any moisture migration through the slab. All joints shall be taped and all penetrations shall be repaired and taped.

12.1.4 **Requirements for metal building:**

(1) The main frames shall be clear span.

(2) The sidewall columns shall be tapered with inset girts.

(3) The bay spacings shall be 25 feet on center.

(4) Primer color shall be standard red.

(5) Arkema's KYNAR 500 26-gauge architectural wall panels, or Owner-approved equal, shall be applied to all exterior walls. Architectural panels shall have semi-concealed fasteners. The Premium 70 finish coating system shall have a superior high-build primer application that is then coated with premium fluorocarbon coating that contains seventy percent (70%) KYNAR 500 resin.

(6) Closure strips, sealing tape, and joint sealants shall be furnished and utilized as needed to complete the metal building erection per Prudent Wind Industry Practices.

(7) To ensure weather tightness and rodent control, a finished base angle at the bottom of each wall sheet shall be included.

(8) Provision for thermal expansion movement of the standing seam panels shall be accomplished by the use of clips with a movable tab.

12.1.5 **Requirements for O&M Building roof:**

(1) The roof pitch shall be 1½:12.

(2) The roof covering shall be American's 24-gauge Aluminum Coated Steel 360º Seamless Roof System or Owner-approved equal. The panels shall be 20-feet wide with 3-inch-high crown. The high crown shall include factory-applied, all-weather mastic. The panel overlaps shall be seamed mechanically to ensure weather tightness of the roof system.

(3) Deluxe eaves which match the rake of the building shall be included.

(4) Dektite boot flashings at 4-inch to 12-inch pipe penetrations shall be provided.

(5) Gutters and downspouts shall be furnished and installed. Splash blocks shall be included at all downspouts. Downspouts shall not drain onto sidewalks or aprons.

12.1.6 **Requirements for O&M Building exterior doors:**

(1) Overhead doors shall include a minimum of one 16-foot by 16-foot door and one 14-foot by 16-foot door, with vinyl seal on both sides of track, hood baffle, reversing "Feather Edge", and take-up reel. Each door shall be motor operated, and openers shall come with three-stage (open/stop/close) push button.

(2) Exterior doors shall be 3-foot by 7-foot commercial-grade, insulated-steel service doors with ball-bearing hinges, hydraulic closer, latch guard, weather-stripping, self-sealing sweep, ADA-compliant aluminum threshold, and keyed lockset. One (1) lite kit shall be included per door, approximate size will be half lite (8-inch by 24-inch).

(3) All door jambs shall be completely flashed to give door opening a finished appearance.

(4) All exterior doors shall be equipped with key card readers, as further described in Section 12.1.16 herein.

(5) All exterior doors shall be equipped with a SCADA-integrated intrusion alarm. Such alarms shall be programmed to provide immediate silent notifications in the event of after-hours and/or non-card-reader access.

(6) Panic hardware shall be provided for exterior shop / warehouse doors and the front entry door, along with any door where local fire codes require they be installed.

(7) All exterior steel doors shall be painted.

(8) Door bumpers shall be provided on every door.

(9) Door keying shall be provided on every door. Bathroom doors shall include dead bolt.

12.1.7 **Requirements for O&M Building interior doors:**

(1) Interior doors shall be 3-foot by 7-foot by 1.75-inch-thick flush solid-core commercial-grade steel doors. All interior doors shall be installed in primed hollow metal frames with three (3) 4.5-inch by 4.5-inch commercial hinges. The frames shall be painted and the doors shall be stained and varnished.

(2) Push/pull hardware shall be installed on all bathroom and break room doors.

(3) Kick-plates shall be installed on all bathroom, break room, shop/warehouse, and front entry doors (note: applies to interior and exterior shop/entry doors).

(4) All doors with push/pull hardware shall include kick-plates installed on push sides.

(5) All interior doors shall have medium-duty commercial lever locksets.

(6) All interior doors and woodwork shall be stained and varnished. All interior hollow metal doors and door frames shall be painted.

(7) Doors shall be fire rated as set forth in Section 12.1.17 (*Fire Protection System*).

(8) Door bumpers shall be provided on every door.

(9) Door keying shall be provided on every door. Bathroom doors shall include dead bolt.

12.1.8 **Requirements for O&M Building windows:**

(1) 4-foot by 5-foot aluminum horizontal slider windows, equal to Plyco Model M3025.

(2) Window frames shall be thermally broken with standard color.

(3) Operable units shall include screens.

(4) Exterior windows shall be glazed with tinted insulated glass and argon gas filled.

(5) Windowsills: wooden sills.

12.1.9 **Requirements for O&M Building room finishes:**

(1) Each room in the O&M Building shall include the minimum finishes set forth in Table 2 (*O&M Building Room Schedule*) and as further described below. Ceiling heights are noted to be nominal heights.

Table 2: O&M Building Room Schedule

Room(s)	Floor	Base	Walls	Ceiling Height	Ceiling Type
Common area Offices Break room Meeting room	Vinyl composition tile	4-inch vinyl	Painted drywall	8'0"	2x4 acoustical tiles
Comm / SCADA	Anti-static vinyl composition tile	4-inch vinyl	Painted drywall	8'0"	2x4 acoustical tiles
Bathrooms	Glazed ceramic/ porcelain tile, with floor drain	4-inch glazed ceramic/ porcelain tile	Ceramic tile/ painted drywall	8'0"	2x4 vinyl covered sheetrock
Shop	Sealed concrete, with floor drain	Not applicable	29 ga. white liner (steel)	18'0"	Exposed structure

(2) Flooring:

(a) All tile shall be waxed. All tile and grout shall be sealed.

(b) Vinyl composition floor tile shall be 12-inch by 12-inch by 1/8-inch tile adhesive applied to concrete floors. Wall base shall be 4-inch high, vinyl base adhesive applied to walls with covered profile.

(c) Porcelain tile shall be set by the thin-set method. Anti-fracture membrane at control joints in floors for bathroom areas shall be provided.

(d) Porcelain wall tile in bathrooms shall be 5-foot high on all sides, with painted drywall above.

(e) Vapor retarder: see Section 12.1.3 herein.

(3) Walls:

(a) All drywall shall be 5/8-inch, taped, sanded, and textured.

(b) All bathroom walls shall have 5/8-inch moisture-resistant drywall with at least two (2) coats of semi-gloss latex applied.

(c) Not used.

(d) A 29-gauge steel liner panel to approximately 8-feet high shall be used along the exposed shop wall. A 2-inch by 2-inch galvanized base angle to attach liner panel at the concrete floor shall be provided.

(e) Walls shall be fire rated as set forth in Section 12.1.17 herein.

(f) Vapor retarder: See Section 12.1.3 for floor vapor retarder requirements.

(g) Retractable wall: not used.

(4) Ceilings:

(a) All ceiling tile shall be Armstrong Cortega or Owner-approved equal.

(b) The ceiling over the electrical storage, storage, and shared workshop shall be covered with 2-inch by 8-foot beams at 16 feet on center with one (1) layer of 7/16-inch OSB over the top. This shall be designed as a dust cover and not a mezzanine.

12.1.10 **Requirements for O&M Building accessories:**

(1) Cabinets shall be installed in the break room. Wall cabinets and hardware shall be wood veneer MDF-type, Owner approved. Cabinets shall be both counter height and overhead.

(2) Countertops shall be installed in the break room. Countertops shall be Corian, or Owner-approved equal.

(3) The following appliances shall be installed in the kitchen / break room. All appliances shall be new, unused, white, and Maytag (or Owner-approved equal).

(a) Microwave.

(b) Refrigerator with ice maker and freezer.

(c) Oven.

(d) Dishwasher.

(e) Commercial ice maker and water dispenser.

(4) The following items shall be provided in the quantities shown:

(a) Men's bathroom:

1. Wall-mounted toilet: 2 (including 1 ADA toilet stall)

2. Urinal: 1

3. Floating sink: 1

4. Shower: 0

(b) Unisex bathroom:

1. Wall-mounted toilet: 1 (including 1 ADA toilet stall)

2. Urinal: 0

3. Floating sink: 1

4. Shower: 0

(c) Kitchen:

1. Sink with faucet: 1

2. Ice maker connection: 0

(d) Shop / warehouse area:

1. Floor sink: 1

2. Wash sink: 1

3. Eye wash station: 1

4. Electric hot water heater, of sufficient size to satisfy the facility's needs: 1

(5) Toilet partitions shall be installed between each toilet and urinal. Partitions shall be wall- and ceiling-mounted with baked enamel finish complete with door, latch, rubber stop, and coat hook at each stall. At least one (1) toilet partition shall conform to ADA standards.

(6) Standard mirrors (approximately 36 inches by 40 inches) shall be furnished and installed in each bathroom.

(7) Paper towel dispensers and toilet paper holders shall be furnished and installed in each bathroom.

(8) Handicap grab-bar hardware shall be furnished and installed in each bathroom stall.

(9) Liquid soap dispensers shall be furnished and installed in each bathroom

(10) At least eight (8) lockers shall be furnished and installed. Each locker shall measure at least 8 feet by 12 inches by 12 inches and each in standard manufacturer's colors. One (1) movable hardwood bench shall be furnished and installed in front of each set of lockers.

12.1.11 **Requirements for O&M Building signage:**

(1) A 6-inch plastic vinyl building address and numbers on the front of the building shall be furnished and installed.

(2) Men's and women's restroom signs shall be furnished and installed.

(3) ADA-compliant and visitor parking sign(s) on steel posts in front of the handicap stalls shall be furnished and installed.

(4) Interior signage, as required by the Applicable Standards and other Requirements, shall be furnished and installed.

(5) A permanent sign at the O&M Building entrance shall be furnished and installed. This sign shall include Project name, Project address, and Owner name/logo, each subject to Owner approval.

12.1.12 **Requirements for O&M Building bollards:**

(1) Bollards shall be installed (a) on each side of the overhead door(s) of the O&M Building; (b) on each side of the oil storage building doors; (c) around the outer four corners of the oil storage building; (d) around each propane tank, backup generator, and HVAC pad, respectively, although if such equipment is adjacent to each other then bollards may not be required around every unit; (e) around the septic tank; and (f) around the perimeter of the septic leach field.

(2) Bollards shall be a minimum 3-inch-diameter steel pipe, concrete filled for equipment protection, painted safety yellow, and extend four (4) feet above grade. Bollards shall be installed no closer than two (2) feet from equipment.

(3) Bollards shall meet the minimum requirements in Section 5.1.18 herein.

12.1.13 **Requirements for O&M Building aprons and sidewalks:**

(1) HVAC pads shall have minimum dimensions of 4 feet by 4 feet by 4 inches.

(2) A concrete slab shall be installed along the length of the O&M Building near the exterior shop door and roll-up doors. Such slab shall be designed to accommodate AASHTO HS44-20 loading.

(3) All aprons and sidewalks shall be reinforced concrete with a broom finish. Minimum thickness shall be 4 inches.

(4) Sidewalk and curb at handicap stall shall be sloped per ADA requirements for handicap access.

(5) Sidewalks and aprons shall have 4-inch ABS sleeve under the structure every 15 feet, at a minimum.

12.1.14 **Requirements for O&M Building parking and driveways:**

(1) The parking area shall be sufficient to simultaneously accommodate parking for at least 10 vehicles and allow deliveries to the O&M Building front entry and warehouse.

(2) All car parking areas shall be shaped and graded for drainage away from the building.

(3) Wheel stops and lighting shall be provided for the parking area.

(4) A concrete slab shall be poured in the parking lot to accommodate ADA parking requirements. Parking lot striping and handicap symbol shall be painted on the concrete paving.

12.1.15 **Requirements for O&M Building fencing and gates:**

(1) The O&M Building perimeter shall be fenced.

(2) At least one (1) vehicle gate shall be installed at the O&M Building. The vehicle gate shall be a double-hung, 20-foot-wide (minimum), swing gate. The gate shall include a latch mechanism for locking with a padlock.

(3) At least one (1) walk gate shall be installed at the O&M Building. The walk gate shall be a lockable, single-hung, 4-foot-wide, swing-gate for personnel access.

(4) All fencing and gates shall comply with the minimum specifications in Section 4.1.8 herein.

12.1.16 **Requirements for O&M Building electronic security system:**

(1) For all access control components, the subcontractor must be "Software House" certified.

(2) Vehicle access control system: not used.

(3) Personnel access control system:

(a) This system shall be installed for all man doors and vehicular gates. The system shall consist of stand-alone distributed smart panels that make the access decision and must have a stand-alone storage database capability that is downloaded routinely to the central computer database. The master computer or any other computer unit that has the proper password must be able to query it. The unit must have different levels of password control to access the data or program the unit.

(b) The card system must use a proximity or RFID card.

(c) This system must have anti-passback capabilities to prevent multiple use of the card in a short time frame. This can be accomplished through read-in and read-out card readers with a timeout feature that prevents multiple uses at the same reader with in a user-defined time frame.

(d) This system must be able to work in a local area network and/or wide area network environment and allow access from other computers on the network.

(e) The software must be capable of providing an audit trail of all who have accessed the database and all changes made by an individual.

(4) Security CCTV system:

Closed-circuit cameras, in the quantity set forth in Section 12.3.1 herein, shall be installed at the O&M Building and connected to the security system. Cameras shall be positioned to allow for monitoring of entry points and major equipment, with final monitoring locations to be approved by Owner.

12.1.17 **Requirements for O&M Building fire protection system:**

(1) The fire protection system shall receive the approval of Owner's insurance carrier.

(2) Portable CO_2 and dry chemical fire extinguishers shall be furnished and installed in the building, in a quantity and type sufficient to ensure compliance with the Applicable Standards and other Requirements. At a minimum, one (1) 10-pound ABC-type fire extinguisher (including mounting device / cabinet) shall be installed at every exit door, break room, and utility room, respectively.

(3) All local alarm, detection, and suppression panels shall report status to the main fire alarm panel located in the control room.

(4) All areas of the O&M Building shall be provided with smoke and heat detectors as the form of fire detection.

(5) The following walls and doors shall be fire rated for the minimum times shown, or as required by the authority having jurisdiction, whichever is greater:

(a) Interior wall between warehouse and office areas: 60 minutes.

(b) Interior doors between warehouse and office area: 60 minutes.

(c) Interior SCADA (if applicable) / communications room walls: 60 minutes

(d) Interior door to SCADA (if applicable) / communications room: 60 minutes

12.1.18 **Requirements for O&M Building potable water system:**

(1) The potable water system shall be designed to provide potable water, both hot and cold, at the proper pressure, temperature, and flow rate to all plumbing fixtures and equipment.

(2) The potable water system shall include chlorination, charcoal filters, or other treatment as required.

(3) All internal water piping shall be copper.

(4) All potable water piping shall be insulated as required and sterilized in accordance with AWWA standards for disinfecting purposes prior to filling.

(5) At least two (2) insulated exterior hose bibs shall be installed.

(6) Water well requirements: [NTC: if applicable]

(a) Contractor shall furnish and install a water supply well. The work includes the excavation of a well bore, furnishing and installing a permanent well casing and screen, providing a gravel pack around the screen; installation of surface well seal; disinfection, development and test pumping of the completed well.

(b) Casing: Contractor shall furnish and install steel well casing and surface casing material conforming to ASTM A53 (Grade B).

(c) Screen: Contractor shall furnish and install a wire-wrapped well screen fabricated of Type 304 stainless steel continuous slot wire wound screen.

(d) Gravel pack: the gravel pack shall consist of hard, durable siliceous particles of washed gravel, containing no flat or elongated particles and not more than five percent (5%) particles with a fractured face. The gravel shall be placed by the tremie method without free fall. The gravel shall be disinfected with a chlorine solution containing not less than 200 milligrams per liter of available chlorine prior to placement in the annular space. The acceptable gravel pack envelope for the production wells will be based on the results of the grain size distribution analysis performed on samples collected from a test hole drilled at the production well site. A multiplier range of 3 to 6 times the d30 (cumulative percent passing) of the finest sample within the screened interval of each production well is acceptable for the filter pack. The gravel pack should have a uniformity coefficient of < 2.5.

(e) Production well seal: seal well after test pumping and after gravel pack thickness lost during development and test pumping is replaced in the well. Install a bentonite chip well seal on top of gravel pack; bentonite seal shall be a minimum thickness of five (5) feet. Install cement grout from the top of the bentonite seal to the bottom of the pitless adapter unit by pressure grouting.

(f) Well development: after construction of the well, the well shall be fully developed in order to obtain its maximum capacity. Contractor shall furnish all necessary pumps, power units, agitator plungers or other needed equipment, and shall develop the well by such approved methods as shall be necessary to give the maximum yield of water per foot of drawdown and extract from the water bearing formation the maximum practical quantity of such sands as may, during the life of the well, be drawn through the screen when the well is pumped under maximum conditions of drawdown. The well shall be bailed, washed, agitated, surged and developed until the water has a turbidity of not greater than 2 nephelometric turbidity units (NTU) and shall pump no sand.

(g) Well test: after the well has been completed and developed, as and to the extent specified in the preceding subparagraph, Contractor shall furnish, install, and operate all test pumping and auxiliary equipment necessary to measure the rate of pumping and determine the drawdown for a period of not less than eight (8) hours at the design pumping rate.

(h) Disinfection: after the well has been completely constructed, it shall be thoroughly cleaned of all foreign substances including tools, timbers, rope, debris of any kind, cement, oil, grease, joint dope and scum. The casing pipe shall be thoroughly swabbed, using alkalis if necessary, to remove oil, grease or joint dope. The well shall then be disinfected with a chlorine solution.

(i) Submersible well pump: Contractor shall supply and install a new turbine submersible pump. Pump specifications will be developed based on the field testing conditions observed during the well pumping test. The pump shall have a minimum efficiency of eighty percent (80%) at the designed operating condition and shall be capable of operation at any condition without operating above the nominal horsepower rating of the pump motor, not including service factor. A check valve shall be installed in the drop pipe, immediately above the pump assembly; the check valve will be installed to prevent backflow into the well.

(j) Pitless adaptor unit: Contractor shall supply and install a Baker Monitor pitless adaptor unit. The unit shall have (a) bury depth sufficient to prevent system from freezing; (b) water-tight cap with screened well vent extending at least two (2) feet above 100-year flood level; and (c) water sampler valve.

(k) Discharge piping: Contractor shall install discharge piping to connect the pitless unit to the new transmission water lines below grade. A flow meter, check valve, and gate valve shall be installed within a valve vault.

(l) Water line: Contractor shall provide a water line piping system complete with pipe, pipe fittings, valves, strainers, expansion loops, pipe hangers, inserts, supports, anchors, guides, sleeves, and accessories with this specification and the drawings. Pipe shall be designed to observe limits on flow velocity, pressure drop and gauge pressure associated with the pipe type and characteristics. All pipe and piping components that come in contact with the water process stream shall be NSF61 approved for potable water contact. Pipe shall be designed to withstand all stresses resulting from external loads and internal pressures listed in the following table plus applicable allowance for surge unless otherwise specified.

(m) Chlorination system: Constructor shall supply a chlorination system that complies with all applicable Requirements.

12.1.19 **Requirements for O&M Building sanitary wastewater:**

(1) Sanitary wastewater shall be collected from the various points of origin in the facility and diverted to a septic tank, and discharge from the septic tank shall be routed to a leach field.

(2) A pumped sanitary wastewater system shall only be used if a gravity system is impractical.

(3) Floor drains shall be installed in the break room, shop area, and each bathroom. The shop area shall include an oil water separator for the shop area drains.

12.1.20 **Requirements for O&M Building heating, ventilating, and air conditioning system:**

(1) Heating elements shall be electric in-floor radiant. Cooling elements shall be electric.

(2) The heating, ventilating, and air conditioning systems shall satisfy the workspace environmental requirements for personnel occupancy and equipment operation.

(3) Minimum ventilation rates shall be provided in normally-occupied areas in accordance with the Applicable Standards and other Requirements. In the absence of local codes, ASHRAE Standard 62 requirements shall be met. A minimum of five (5) air changes per hour of ventilation or recirculation air shall be provided for effective mixing during heat removal ventilation or air conditioning of normally occupied spaces.

(4) The air conditioning for control and electrical equipment shall be designed to meet the filtration levels as defined by ASHRAE Standard 52.

(5) Interior cooling loads for the SCADA room (if located in O&M building) shall be based upon actual equipment to be installed and ASHRAE Standard requirements. This air conditioning unit shall be ceiling mounted.

(6) Air velocities in ducts and from louvers and grills shall be sufficiently low to maintain acceptable noise levels in areas where personnel are normally located.

(7) Thermal insulation with vapor barrier shall be provided on ductwork surfaces with a temperature below the dew point of the surrounding atmosphere to prevent vapor condensation. All ductwork used for air conditioning purposes shall be insulated; ductwork used for ventilation purposes shall not require insulation.

(8) Exhaust fans for bathrooms and locker room shall be furnished and installed. Exhaust systems shall be provided above the roof for toilet, shower and locker room areas and shall be controlled by occupancy sensors. Outdoor ventilation air shall be based on normal room occupancy or local codes, whichever is more stringent.

(9) Functional louvers at building workshop area shall be provided.

12.1.21 **Requirements for O&M Building insulation systems / thermal and moisture protection:**

(1) Caulking and backer board, as recommended by the manufacturer and to seal exterior and interior joints at expansion joints, frames of doors, windows, and other wall openings, shall be furnished and installed.

(2) Roof insulation shall be such that an *R* value of at least 30 is achieved. Thermal blocks shall be included within the roof system.

(3) All building walls shall be insulated. Wall insulation shall be such that an *R* value of at least 19 is achieved. All interior office walls shall be insulated with 3.5-inch fiberglass batt insulation for sound control.

(4) Miscellaneous insulation for filling voids at roof eave, roof peak, door frames, window frames, and other similar areas shall be furnished and installed.

12.1.22 **Requirements for O&M Building electrical service, general:**

(1) All convenience outlets shall be on 20A circuits.

(2) All equipment and materials shall bear UL label.

(3) Underground conduit shall be PVC and shall conform to the specifications for conduit set forth herein.

(4) All transformers shall be installed exterior to the building.

(5) Install receptacle outlets as specified in accordance with NFPA 70/NEC.

12.1.23 **Requirements for O&M Building grounding:**

(1) Grounding shall be in accordance with NFPA 70/NEC. All feeder and branch circuits shall have a green-colored insulated equipment ground conductor in addition to any metallic conduit being bonded to the equipment grounding system.

(2) Ground fault protection shall be installed in receptacles in warehouse and workshop where power tools are used, and in restrooms and other locations as required by NFPA 70/NEC.

(3) The facility shall have a #4/0 AWG bare copper ground counterpoise with 0.75-inch by 10-foot copper-clad steel ground rods. The counterpoise will be connected to service entrance equipment, derived source transformer secondary neutrals, telecommunications main ground bus bar, and all building columns.

(4) The building shall have an array of air terminals, roof conductors, and down conductors. The lightning protection system shall be interconnected to the ground counterpoise system. Requirements for the building's lightning protection system shall be as determined and recommended by NFPA 780.

12.1.24 **Requirements for O&M Building power distribution system:**

(1) Service entrance conductors shall be installed to tie into the main distribution panel and terminated and tested by Contractor. The main distribution panel in the building shall be service-entrance rated.

(2) Feeders shall extend from the main distribution panel to serve general power panel boards.

(3) Panel boards and associated feeders shall be sized for twenty percent (20%) spare capacity. Panel boards shall contain space for twenty percent (20%) additional spare circuit breakers.

(4) Building electrical service shall include an automatic transfer switch and pad-mounted propane generator. The backup service shall be sized equal to the utility service and provided with sufficient fuel to operate for a minimum of two (2) days without refueling.

12.1.25 **Requirements for O&M Building wiring and conduit:**

(1) Each length of PVC conduit furnished with coupling on one end and metal or plastic thread protector on the other end. Sizes of conduit, fittings and accessories as indicated, specified or as required by Applicable Standards or in accordance with NFPA 70/NEC requirements.

(2) Terminate all conduit runs with insulated bushings.

(3) Provide all fittings necessary for a complete installation.

(4) Lighting branch circuits, telephone circuits, fiber optic cables and intercommunications circuits shall be routed in separate conduit systems. Lighting circuits shall be routed in electrical metallic tubing for indoor concealed areas, rigid conduit for outdoor areas, and PVC tubing or Schedule 40 PVC conduit for underground.

(5) Threaded, galvanized, rigid steel conduit or intermediate metal conduit shall be PVC tape wrapped or coated for underground use and will be used in all exposed, outdoor and hazardous locations.

(6) All conductors shall be copper.

(7) All conductors #10 AWG and smaller shall be solid conductor. All conductors #8 AWG and larger shall be stranded conductor.

(8) All feeder and branch circuit wire shall be single conductor and have THWN/THHN insulation.

(9) All electrical enclosures mounted outdoors shall be NEMA compliant (3R/3S/3X/4X, based on project location/requirements), stainless or aluminum.

(10) Isolate emergency lighting circuit conductors from all other wiring.

12.1.26 **Requirements for O&M Building exterior lighting:**

(1) Exterior lighting shall be provided by building-mounted, metal-halide or LED light fixtures at facility personnel and overhead doors. Additional building-mounted lights shall be provided to illuminate walkway and parking area. LED lights are preferred if minimum required illumination levels can be met. In lieu of LED lights, metal halide lights may be used, with Owner approval. Lighting levels shall meet the intensities indicated in the IES handbook and NFPA 70/NEC.

(2) Exterior lighting shall be controlled by lighting contactors with hands-off auto selector switches and photocells and should be equipped with vandal-resistant lenses.

(3) Lighting shall be provided to cover the building faces evenly and shall be directed inward from the property line.

(4) Area lighting shall supplement existing street lighting (if any) to provide a maximum level of illumination from a minimum number of fixtures. The system shall be designed to illuminate the entire area evenly, including doorways, structures, and all opening into the structures.

(5) Pedestrian and vehicle entrances that are actively used are to be provided with sufficient illumination to permit recognition of individuals and examination of credentials. All vehicle entrances must be lit so that the entire vehicle, occupants, and contents can be adequately viewed. Doorways and other recesses must be lit to eliminate shadows.

(6) Alternate circuitry must be used in the power circuits so that the failure of any one lamp does not leave a large portion of either (a) the site perimeter or (b) critical or vulnerable areas in darkness.

12.1.27 **Requirements for O&M Building emergency lighting:**

(1) The facility shall use fluorescent fixtures with internal battery backup ballast for emergency egress locations such as corridors, hallways, and fire exits.

(2) Exit signs shall be illuminated LED type located at fire exits and required locations.

12.1.28 **Requirements for O&M Building interior lighting:**

(1) Lighting levels shall meet the intensities indicated in the IES handbook and NFPA 70/NEC. The facility shall use the following types of fixtures: (a) 1-inch by 4-inch industrial LED fixtures with guards with at least two (2) lamps in storage areas and SCADA room (if applicable), respectively; (b) 2-inch by 4-inch LED fixtures with parabolic louvers with at least three (3) lamps with dual level switching in office areas, break room, and conference room, respectively; and (c) 2-inch by 4-inch high bay I-beam LED fixtures with four (4) T5 high-output linear fluorescent lamps in workshop area.

(2) LED fixtures shall be equipped with high-efficiency electronic ballasts. Classified area lighting fixtures shall be designed to meet requirements of NFPA 70/NEC, Article 500.

(3) A lighting control system shall be used to control fixtures in office areas. The lighting control system will have local low voltage switches for local control. Offices will be locally switched and have motion sensors to shut off the circuit automatically when the room is unoccupied.

12.1.29 **Requirements for O&M Building communications:**

(1) A complete telephone and data network system shall be provided including all distribution jacks, cable, and wireless systems.

(2) Internet service shall include (a) high-speed internet service (Wi-Fi) throughout the building and (b) broadband internet service up to the wall jacks. T1 service shall be provided (or the fastest available speed from the local service provider).

(3) Phone service shall include four-line phone system up to the wall jacks.

12.1.30 **Requirements for O&M Building garbage enclosure: Not used.**

12.1.31 **Requirements for O&M Building oil storage building:**

(1) The O&M Building shall include a separate, detached building for oil storage and garage space. The building shall be installed at an Owner-approved location.

(2) The Oil Storage, Garage Building shall have the outer dimensions and indicative layout shown in Exhibit 10 (*Oil Storage, Garage Sample Floorplan*) herein, at a minimum.

(3) The oil storage building shall be constructed using metal studs.

(4) The oil storage building shall have a ramped entry on the door side, sufficient to allow forklift access and with a minimum 5-foot concrete slab extension.

(5) A concrete floor shall be installed throughout the interior of the oil storage building.

(a) The floor shall include concrete curbs on all sides of the garage bay nearest the O&M Building, each at least 6-inches high.

(b) A non-skid steel grate shall be furnished and installed above the concrete floor. The grating shall be elevated approximately six (6) inches above the concrete floor.

(c) The concrete floor shall be safely sloped towards a Contractor-installed sump pit in the rear corner of the building, which shall include a Contractor-furnished and Contractor-installed sump pump. The pump shall be used to manually remove effluent as needed; automatic discharge is not expected.

(d) The concrete floor (including the elevated grating) shall be designed with sufficient structural capacity to simultaneously support the load of a standard, loaded fork lift and other stored materials. At least 15,000 pounds of floor load capacity shall be provided.

(6) The oil storage building shall have a metal roof which shall be slanted away from the door side and which shall be designed with similar loading criteria as was used for the O&M Building. The roof pitch for the oil storage building shall match the roof pitch utilized on the O&M Building.

(7) The oil storage building shall have power, heating, and lighting installed and operable.

(8) The oil storage building shall include ventilation for chemical storage.

(9) The interior of the building shall have at least 10 feet of clearance from floor to ceiling, or more if necessary to permit safe forklift access and use.

(10) One (1) eye wash station shall be furnished and installed in the oil storage building. Eye wash bottles may be substituted where they satisfy local regulations.

(11) Portable CO_2 and dry chemical fire extinguishers shall be furnished and installed in the oil storage building, in a quantity and type sufficient to ensure compliance with the Applicable Standards and other requirements. At a minimum, one (1) 10-pound ABC-type fire extinguisher (including mounting device / cabinet) shall be installed in the building.

(12) Minimum signage, exterior of oil storage building:

(a) No smoking.

(b) No open flames.

(c) Maximum floor capacity (including loaded forklift).

(d) Personal protective equipment requirements.

(e) Authorized personnel only.

(13) Minimum signage, interior of oil storage building:

(a) Eye wash station.

(b) Fire extinguisher location.

12.1.32 **Requirements for O&M Building storm shelter: The SCADA room (if located in O&M building) shall be designed in a manner to act as a storm shelter.**

(1) The storm shelter shall be (a) ventilated; (b) compliant with FEMA 320, FEMA 361, and ICC 500; and (c) sufficient in size to safely and comfortably accommodate up to 30 adults.

(2) The storm shelter shall be installed at an Owner-approved location.

(3) Grading shall divert water flow away from the storm shelter.

12.2 Submittals

12.2.1 **Contractor shall prepare the O&M Building design documents per The Submittal Schedule and containing the following information, at a minimum: (a) electrical works, including grounding and lighting plans, one-line diagrams, electrical load list, power distribution board, communications, and construction specifications; (b) civil works, including site plan, subgrade preparation, grading/drainage, paving plan/design, and laydown area; (c) structural works, including structural steel drawings, foundation and equipment pads (locations and details), rebar, design calculations, and construction specifications; (d) mechanical works, including equipment arrangements/locations, equipment list, HVAC layout, fire protection and monitoring, piping and plumbing, vendor drawings (as applicable), and construction specifications; (e) architectural works, including building layout/plans/elevations, finishes, schedules for windows and doors, and hardware; (f) drawing index; (g) bill of materials; and (h) inspection, testing, and quality control requirements.**

12.2.2 **Contractor shall provide a water quality test report for the O&M Building water supply if a well is the primary source of potable water.**

12.2.3 **Contractor shall submit material and color (interior/exterior) samples for Owner approval.**

12.2.4 **Contractor shall submit copies of manufacturer warranties and operation manuals for all permanent-installed equipment and materials.**

12.2.5 **Contractor shall submit manufacturer's approval drawings or product sheets (material cut sheets) for all permanently-installed equipment and materials. This shall include, but is not limited to, generators, transformer, electrical panels, signage, fixtures, appliances, and other similar items.**

12.3 O&M Building

12.3.1 **Contractor shall design, furnish, construct, and install one (1) O&M Building.**

(1) The O&M Building shall be constructed at the location shown on Exhibit [●] (*Project Site Plan Exhibit Name*).

(2) Contractor shall furnish all labor, equipment, and materials that are necessary for a complete, fully-functional, and safe O&M Building configuration.

(3) Contractor shall furnish and install a backup generator for the O&M Building.

(4) Contractor shall design, furnish, construct, and install one (1) oil storage, garage building at the O&M building.

(5) Contractor shall furnish and install one (1) storm shelter at the O&M building. room.

(6) Contractor shall furnish and install fencing around the perimeter of the O&M Building, including one (1) man-gate and at least one (1) vehicle gate, respectively.

(7) Contractor shall provide professional cleaning service for the O&M Building at the conclusion of the Work, including, but not limited to, cleaning light fixtures, mirrors, sinks, toilets, cabinets, and lockers; washing floors; washing windows; and waxing VCT.

(8) Contractor shall furnish and install closed-circuit cameras at the O&M Building. Cameras shall be positioned to allow for monitoring of entry points and major equipment, with final quantities and monitoring locations to be approved by Owner.

13.0 AIRCRAFT DETECTION LIGHTING SYSTEM

13.1 General Provisions

13.1.1 **Requirements for ADLS civil and structural works:**

(1) All civil and structural works including, but not limited to, grading, structures, foundations, assemblies, and components for the ADLS shall be designed and constructed in accordance with the applicable specifications in Section 4.0 *(Civil /* Structural Works).

13.1.2 **Radar towers shall be self-supported (non-guyed), galvanized lattice structures, each tower shall be designed and certified for the maximum wind and ice loading for the Project Site conditions.**

13.1.3 **All FAA obstruction lights shall be of the same make and model and consistent with the requirements in Section 10.4.3 and shall be compatible with the Wind Turbine and ADLS communication system, respectively.**

13.1.4 **The ADLS shall detect when an aircraft is at a defined outer perimeter around the Project Site and place the Wind Turbine aircraft obstruction lighting system in the "ON" state. When aircraft is outside of the defined perimeter of the Project Site, the ADLS system shall maintain the lights in the "OFF" state to minimize light pollution from the obstruction lighting.**

(1) A failure of the ADLS radar system shall be automatically detected and place the obstruction lights in the "ON" state.

13.1.5 **Contractor shall perform all required studies and analyses of the Project Site for siting of the ADLS radar tower(s). Contractor shall propose a minimum of two potential locations for the ADLS Radar tower(s) within the Project boundary on participating landowner parcels. Potential locations shall provide adequate coverage for the entire Project site.**

(1) Contractor shall optimize the system considering items such as number of radar towers, radar tower height, available tower locations, distance from Collection System Circuits, etc. Contractor shall actively attempt to minimize the number of tower locations for the Project Site.

(2) Contractor shall coordinate the selection of the radar tower location(s) that are studied / analyzed and the final selected radar tower location(s) with the Owner. Selection of the radar tower location(s) shall include a site visit by the ADLS manufacturer prior to finalizing the tower location(s) to confirm the suitability of each location.

13.1.6 **Requirements for power supply:**

(1) Power for each radar shall be derived from the nearest Collection System Circuit or via a nearby Project source (e.g., O&M Building, Substation).

(2) Power cable shall be installed at the same depth as the Project Collection System, unless otherwise explicitly approved by Owner.

(3) The Collection System Circuit cable power the ADLS shall include a 34.5-kV junction box extending the 34.5-kV cable from the junction box to each radar tower location. An oil-filled, distribution style pad-mounted transformer (with the requirements as in Section 5.1.14) and low-voltage Nema 4 distribution panelboard shall be utilized to step down the power to the required low voltage of the radar tower to power the radar devices.

(a) The following exceptions are made to the requirements of the pad-mounted transformer as noted in Table 1:

1. MV bushings: (2 or 3) 200A or (2 or 3) 600A.

2. Phases: One (1) or Three (3)

3. Vector Group HV/LV: HV = Ungrounded (Single phase or Delta) / LV = Grounded (single phase or Delta or Wye) as specified by Engineer of Record to provide the ADLS power requirements. Note that a three-phase transformer with a 34.5 kV Delta high voltage winding and a low voltage winding of 240V Delta with a center tap bonded to ground on one phase is allowed as a means of providing a solidly grounded low voltage system with both 240V three phase and 120/240V single phase power.

4. Grounding: Solid (MV source, LV winding); un-grounded delta or single phase 34.5 kV (MV winding on transformer)

5. Temperature gauge; Nitrogen pressure level indicator; Oil sampling valve; Nitrogen filling orifice: Option pricing for instrument being located in an external padlockable compartment is not required.

6. Infrared viewing windows with metal cover: Option pricing is not required.

13.1.7 **Requirements for ADLS communications:**

(1) The ADLS communication system shall comply with the applicable requirements in Section 8.0 (*Communication Systems*).

(2) The ADLS communication system shall be capable of controlling and communicating between the Wind Turbine obstruction lights and Owner's SCADA system with reporting/view-only function available at the Project Substation.

(3) Communications for each tower location shall include the installation of direct buried fiber optic cable extending to the ADLS radar tower.

(4) The ADLS fiber cable shall be co-located with the power cable.

13.1.8 **Requirements for ADLS grounding:**

(1) The grounding system for the ADLS tower shall include a ground ring at least three (3) feet outside the perimeter fence of the ADLS tower and shall be bonded to the fence, tower, and electrical system. It shall be designed as required to meet acceptable levels of both touch and step potential and ground potential rise. See Section 6.1.22 for grounding system requirements.

13.1.9 **Contractor shall comply with all applicable permits, the AHJ, the Federal Communications Commission ("FCC"), the FAA, and any applicable rules established by the state and the [State Public Service / Utility Commission].**

13.2 Submittals

13.2.1 **Contractor shall submit for Owner review the locations to be studied / analyzed for each radar tower prior to proceeding with study of the location.**

13.2.2 **Contractor shall submit for Owner review the study / analysis for each radar location including, but not limited to the viewshed analysis for each location, required height of the radar tower structure.**

13.2.3 **Contractor shall prepare the ADLS design documents per the submittal schedule in Exhibit TBD (*Submittal Schedule Exhibit Name*) and containing the following information, at a minimum: (a) general arrangement plan and physical layout diagrams; (b) civil works drawings; (d) one-line diagrams, wiring diagrams, schematics. (e) communications block diagram, including all Communications System equipment, Owner-Supplied Equipment, and turbine manufacturer supplied equipment; (f) Communications System details, including HMI screen development, and fiber termination diagrams; (g) cable specifications and arrangements; (h) conduit and cable schedules; (i) panel schedules; (j) elevation drawings; (k) structural design documents, including foundation plans and details (with structural calculations to be provided with each set of foundation drawings); shop drawings showing fabrication of structural-steel components; details of cuts, connections, splices, camber, holes, and other pertinent data; indication of welds by standard AWS symbols, distinguishing between shop and field welds, and showing size, length, and type of each weld; indication of type, size, and length of bolts, distinguishing between shop and field bolts; mill test reports and structural steel properties, including chemical and physical; and fastener properties (mechanical/chemical), including bolts, nuts, and washers, and indicating coatings used to satisfy anchor bolt protection plan; (l) ground grid calculations; (m) ground grid plans; (n) conduit details; (o) fencing and gate details; (p) drawing index; (q) bill of materials; and (r) inspection, testing, and quality control requirements.**

13.2.4 **Contractor shall submit for Owner review and approval all manufacturer's product sheets (material cut sheets), warranties, and operations and maintenance manuals (as applicable) for all permanently installed equipment and materials, including but not limited to:**

(1) Radar system including its control system components and power requirements.

(2) Obstruction lighting and lighting communication modules.

(3) Radar tower.

(4) Pad-mount transformer.

(5) Distribution panelboard.

13.2.5 **Contractor shall submit for Owner review a description of the data that is provided by the ADLS to the SCADA system and sample reports that can be generated by the SCADA system that provide the performance data for the ADLS.**

13.2.6 **Contractor shall provide a complete recommended spare parts list for the ADLS system. Such list shall include recommended quantities, part / model numbers, and nominal pricing.**

13.2.7 **Contractor shall submit all required permits or approvals obtained for the ADLS system for Owner review**

13.3 Aircraft Detection Lighting System

13.3.1 **Contractor shall design, furnish, construct, and install an ADLS, radar-controlled aircraft obstruction lighting system for the Project. The ADLS-controlled lighting system shall include, but not be limited to, the power supply, grounding / surge protection, communications, radar tower structure, fencing and gates, access roads, ADLS radar, Wind Turbine obstruction lighting, lighting control modules, ancillary equipment, and any other materials or work as necessary to provide a complete and functioning system.**

13.3.2 **Contractor shall furnish all labor, equipment, and materials that are necessary for a complete, fully-functional, and safe ADLS radar-controlled lighting system.**

13.3.3 **Contractor shall furnish and install fencing and gates around each ADLS radar.**

(1) A perimeter fence with at least one gate entrance shall surround the radar tower site including the tower, pad-mounted transformer, distribution panelboard, radar control and communications equipment.

(2) Fencing shall be placed to allow a minimum of 10 feet of free space around the radar tower base including the transformer, panelboard, and radar control equipment. Fencing shall be grounded. The gate shall be a lockable swing-gate, sufficiently wide for light-duty vehicle access. See Section 4.1.6 for fencing and gate requirements.

(3) The fenced area for the radar tower shall be covered throughout with at least six (6) inches of aggregate over a compacted subgrade, with aggregate extending at least one (1) foot beyond the fence in all directions and using the same aggregate material as the Site Access Roads.

13.3.4 **Contractor shall furnish and install a 12-foot-wide road to each radar tower. Such roads shall be constructed of the same materials and with the same cross section as the Site Access Roads. See Section 4.4 for site road requirements.**

13.4 Testing and Quality Control

13.4.1 **Contractor testing plan for the ADLS system shall be submitted to Owner for review and approval. Contractor shall notify Owner of all testing schedules at least 30 days in advance of testing activities and copies of testing reports (including a summary of testing procedures and acceptance criteria) shall be submitted to Owner within 10 days of completing such test.**

13.4.2 **The ADLS system communication testing shall comply with Section 8.4.**

13.4.3 **Acceptance of the Work shall be determined by Owner only when the ADLS is fully commissioned including, but not limited to, remote access capability, ADLS report generation capability, and the ADLS is in compliance with the Requirements.**

14.0 EXHIBIT 1 - SUBMITTAL REQUIREMENTS

Without limiting the information summarized herein, the purpose of this exhibit is to summarize the minimum requirements for Contractor-provided submittals, including Contractor Deliverables.

A. General requirements:

1. Contractor shall name and label all submittals using an Owner-approved naming convention. Such naming convention shall be used consistently for all submittals, and the only filename modification for revised submittals shall be a change in revision number. Unidentifiable submittals will be returned for proper identification.

2. Submittals shall be accompanied by copies of native, electronic design files (e.g., AutoCAD .dwg file, PLS-CADD .bak file, electrical model files (PSS/E, EasyPower, ETAP, CYME), etc.), including for interim design transmittals (e.g., 30%, 90%, etc. as applicable) and As-Built Drawings.

3. All design submittals shall be provided in a common and consistent coordinate system. Such coordinate system shall be subject to Owner approval.

4. All design submittals (including product sheets, mix designs, verification procedures, installation procedures, testing procedures, etc.) shall be approved by the applicable engineer of record prior to submitting to Owner.

B. Quality requirements:

1. Scanned submittals are not acceptable. All submittal text shall be electronically recognizable and searchable.

2. Submittals to Owner shall be of suitable quality for legibility and reproduction purposes. Every line, character, and letter shall be clearly legible. Drawings shall be useable for further reproduction to yield legible hard copies.

3. Documents submitted to Owner that do not conform to specified requirements shall be subject to rejection by Owner, and upon request, Contractor shall resubmit conforming documents. If conforming submittals cannot be obtained, such documents shall be retraced, redrawn, or photographically restored as may be necessary to meet such requirements. Contractor's (or its subcontractor's) failure to initially satisfy the legibility quality requirements will not relieve Contractor (or its subcontractors) from meeting the required schedule for submittals, as prescribed in The Submittal Schedule or elsewhere in the Agreement.

C. Quantity requirements:

1. Contractor shall electronically transmit one (1) copy of all submittals to Owner, including modifications to submittals, except as otherwise specified herein or elsewhere in the Agreement.

2. Contractor shall transmit submittals as hard copy format (if required) in the quantities set forth herein or elsewhere in the Agreement.

D. Languages and dimensions:

1. All words shall be in the English language.

2. All dimensional units shall be in English units. When both metric and English units of measurement are presented, English dimensional units shall prevail.

3. All drawings and dimensions shall be to scale; not-to-scale ("**NTS**") dimensions will not be permitted on scalable drawings. A scale bar shall be included to permit use following photo-reduction.

E. Submittal completeness:

1. Submittals shall be complete with respect to dimensions, design criteria, materials of construction, and other information specified to enable Owner to review the information effectively.

2. Where standard drawings are furnished which cover a number of variations of the general class of equipment, each drawing shall be annotated to indicate exactly which parts of the drawing apply to the equipment being furnished. Use hatch marks to indicate variations which do not apply to the submittal. The use of "highlighting markers" will not be an acceptable means of annotating submittals. Such annotation shall also include proper identification of the submittal permanently attached to the drawing.

F. Transmittal of submittals:

1. Submittals and Project documents shall be transmitted in (a) nonproprietary, native electronic format, incorporating any necessary reference files; and/or (b) Adobe (*.pdf) files created directly from native electronic format.

2. All electronic submittals shall be uploaded to Owner's web-based document management site. Selected submittals may also be required to be provided on CD, DVD, or flash drive, as specifically prescribed herein.

3. All electronic submittals shall be clearly named and versioned (e.g., revision number, date appended to file name).

4. Each submittal shall be accompanied by a completed transmittal letter. Submittals that are not accompanied by a completed transmittal letter will not be accepted and will be returned to Contractor. All Contractor transmittal letters submitted to Owner shall contain the following information, at a minimum: (a) transmittal number; (b) date of transmittal; (c) Contractor's name; (d) Project name; (e) Owner's project number; (f) filename and revision number; (g) description of the information contained in the specific transmittal; and (h) purpose of transmitting to Owner (i.e., issued for information, issued for review, etc.), including applicable Agreement references.

5. Contractor shall provide a transmittal notification email to Owner at the time of each submittal. The completed transmittal letter shall be attached to the notification email.

6. Contractor shall, at the time of each submission, call to the attention of Owner in the letter of transmittal any deviations from the Requirements.

7. Contractor shall check and approve submittals of subcontractors and manufacturers prior to transmitting them to Owner. Contractor's submission shall constitute a representation to Owner that Contractor approves such submittal(s) and has determined and verified all information contained therein, and Contractor assumes full responsibility for doing so; and Contractor has coordinated each submittal with requirements of the Work and the Agreement.

8. Contractor shall cause the applicable engineer(s) of record to review and approve the submittal prior to transmitting it to Owner. An approval stamp from such engineer(s) of record shall be included on the submittal to indicate such approval.

G. Owner's review:

1. Owner's review and approval of submittals will not relieve Contractor of responsibility for any deviation from the Requirements unless Contractor has in writing called Owner's attention to such deviation at the time of submission, and Owner has given written concurrence in and approval of the specific deviation. Approval by Owner shall not relieve Contractor from responsibility for errors or omissions in submittals.

2. Contractor shall make all modifications noted or indicated by Owner and return the required number of revised submittals until approved. Direct specific attention in writing, or on revised submittals, to changes other than the modifications called for by Owner on previous submittals. After submittals have been approved, submit copies thereof for final distribution. Previously-approved submittals transmitted for final distribution will not be further reviewed and are not to be revised. If errors are discovered during manufacture or fabrication, correct the submittal and resubmit for review.

3. Contractor shall submit equipment catalog cut sheets for Owner review and approval prior to procurement.

H. Design submittals:

1. All design submittals shall bear the Project name, the status of the submittal (e.g., Preliminary, Issued for Bid, Issued for Construction, As Built), and shall be sequentially numbered with a unique identifier.

2. Issued-for-construction drawings shall not be changed or substantially-deviated from without Owner approval.

3. As-Built Drawings: As-Built Drawings shall be issued as the next sequential revision from previous releases. The revision block shall state "As Built". All clouds, revision diamonds, and other interim control markings shall be removed, and all information listed as "later" or "hold" shall be completed. The As-Built Drawings shall include a final bill of materials, and native copies of all drawings and layouts. As-Built Drawings shall be created in the latest version of AutoCAD, or in the version of AutoCAD utilized by Owner, as applicable.

4. All materials shall be fully identified by Contractor, and each engineering package shall include a bill of materials, including all equipment and materials to be procured. Every item in the bill of materials shall have a unique identifier (typically numerical). Each bill of materials shall list product name, manufacturer, unique product / part number, and quantity.

5. All engineering shall be performed under the supervision of and stamped by the engineer(s) of record, who shall be a registered professional engineer with a current license in the [Project jurisdiction / state of TBD]. Such professional engineer(s) shall be registered in the applicable discipline for the drawings being signed and sealed.

15.0 EXHIBIT 2 - SCHEDULE REQUIREMENTS

Without limiting the information summarized herein, the purpose of this attachment is to summarize the minimum contents and requirements for the Contractor-prepared Project Schedule.

A. Definitions:

1. For purposes of only this attachment, the following words shall have the respective meanings set forth below.

   a. "**Activity**" means a discrete part of a contract that can be identified for planning, scheduling, monitoring, and controlling the construction Work. Activities included in a construction schedule consume time and resources but shall not include planned work stoppages. Activities shall not normally reflect the Work of more than one trade.

   b. "**Baseline**" schedule means the initial Project Schedule, as approved by Owner.

   c. "**Critical path**" means the longest sequence of activities in a project plan which must be completed on time for that project to complete by the stated due date.

   d. "**Critical path method**" or "**CPM**" means a method of planning and scheduling a construction contract where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Agreement.

   e. "**Float**" means the measure of leeway in starting and completing an activity. Float time (including total float) is not for the exclusive use or benefit of either Owner or Contractor, but is a jointly-owned, expiring Project resource available to both parties as needed to meet schedule milestones and Agreement completion date.

   f. "**Predecessor activity**" means an activity that precedes another activity in the network.

   g. "**Resource loading**" means the allocation of manpower, equipment, or material necessary for the completion of an activity as scheduled.

   h. "**Successor activity**" means an activity that follows another activity in the network.

   i. "**Total float**" is the measure of leeway in starting or completing an activity without adversely affecting an intermediate deadline or the planned Agreement completion date.

j. “**Milestone**” means [TBD].

B. General requirements:

1. Contractor’s accepted Baseline schedule will be set forth in Exhibit [●] (*Project Schedule*).

2. Contractor shall utilize Primavera Professional Project Management Software from Oracle for preparation of the Project Schedule. At a minimum, this shall be version Primavera P6.7 or newer.

3. Activities in the Project Schedule shall be defined so that no single construction activity is longer than 20 calendar days and no single other activity is longer than 30 calendar days, respectively, unless specifically allowed by Owner.

4. The Project Schedule shall include a clear and logical work breakdown structure, wherein all items are assigned a sensible activity number based upon the type of work being performed. Such work breakdown structure shall be subject to approval by Owner. Activity numbering shall be such that predecessor activity numbers are smaller numerically than successor activity numbers in the Baseline Project Schedule. Contractor shall use even-numbered activities for base Agreement Work, and odd-numbered activities for change order work. No activity number shall change after approval of the Baseline Project Schedule.

5. Procurement process activities shall be included for all long-lead and major items (as defined by Owner) as separate activities in the Project Schedule. Procurement cycle activities shall include, but not be limited to, submittals, approvals, purchasing, fabrication, and delivery.

6. The Project Schedule shall indicate important stages of construction for each major portion of the Work, including, but not limited to, the following: (a) preparation and processing of submittals; (b) mobilization and demobilization; (c) acquisition of key permits; (d) purchase, fabrication, and delivery of major equipment; (e) installation; (f) utility interruptions; (g) tests and inspections; (h) startup and initial operations; (i) work by Owner that may affect or be affected by Contractor’s activities; and (j) training.

7. The Project Schedule shall include Milestones indicated in the Agreement. All major milestones shall be presented at the top of the Project Schedule.

8. The Project Schedule shall show the Work in Gantt chart format, on a sheet size of 11-inch by 17-inch, the scale and spacing shall allow room for notation and revisions, and the font shall be sized such that it is easily legible when printed.

9. Each revised or updated Project Schedule shall show actual progress compared to the originally-accepted Baseline schedule and any proposed changes in the schedule of remaining Work.

10. The Project Schedule shall clearly identify all critical path activities. Scheduled start and completion dates shall be consistent with Agreement milestone dates.

11. Contractor shall not use artificial activity durations, preferential logic, or other devices for sequestering Float. Owner retains the right to reject any schedule submittal in which Contractor has sequestered Float. Any activity with lag greater than two (2) days shall be identified in the activity description.

12. Constraint dates shall be kept to a minimum, and all constraints shall be identified with descriptive text in the activity description.

13. All activities shall have a predecessor activity and successor activity except for the first and last activities in the Project Schedule.

14. Each Project Schedule shall meet the minimum requirements for submittals set forth in Exhibit 1 (*Submittal Requirements*) to this exhibit.

C. Concurrent with each Project Schedule submittal, Contractor shall submit the following reports. Each such report shall contain, at a minimum, activity number, activity description, resource loading, original duration, remaining duration, early finish date, late start date, late finish date (or actual start date and/or actual finish date, as applicable), and total float in calendar days.

1. General: electronic copies of the complete Project Schedule file in P6 executable (*.xer) format (including the Project-specific *.plf layout filters) and Adobe (*.pdf) format, respectively.

2. Critical path report: list of all activities on critical path, sorted in ascending order by activity number.

3. Activity report: list of all activities sorted by activity number and then start date, or actual start date if known. Within each activity, Contractor shall indicate estimated completion percentage in no greater than 10 percent (10%) increments.

4. Logic report: list of preceding and succeeding activities for all activities, sorted in ascending order by activity number.

5. Total float report: list of all activities sorted in ascending order by activity number and showing total float by activity.

6. Three-week look ahead: list of all planned Work activities during the current week and the subsequent two-week interval, sorted in ascending order by activity number.

7. Tabulated reports and/or schedule layouts showing the following: (a) identification of activities that have been added, deleted, or changed; (b) changes in activity durations in workdays; (c) changes in total float; (d) detailed schedule layout showing start and finish date variances; (e) critical path and near critical path (1 to 15 days float) layout with variances; (f) major milestone report with variances; and (g) activity constraints, including type.

16.0 EXHIBIT 3 - APPLICABLE STANDARDS

Without limiting the information summarized herein, the purpose of this attachment is to summarize the applicable industry codes and standards for Contractor's Work.

A. General requirements:

1. The Applicable Standards shall include (a) each of the standards and industry codes listed below and (b) each of the relevant standards and codes issued by the organizations listed below. For the avoidance of doubt, any standards or industry codes not identified herein but pertinent to the Work shall also apply.

2. Unless otherwise specified, all engineering, procurement, and construction associated with the Project shall comply with the latest revision of all applicable codes and standards including, but not limited to, those listed herein. Any departure from the referenced codes and standards must be fully explained in writing and submitted for Owner's review and approval prior to implementation.

3. All specific standards applicable to pieces of equipment, structures, and/or buildings may not be listed herein. Specifications may describe the specific standards that may apply.

4. Any general standard or organization listed below shall be understood to include all relevant codes, standards, and/or guidelines under that particular standard or organization. For example, ACI shall include ACI 301, ACI 305, ACI 306, ACI 318, etc.

5. Unless otherwise specified herein, in the case of conflict between any Applicable Standards, the more stringent requirement shall apply.

B. Applicable Standards:

1. Aluminum Association ("AA")

2. American Association of State Highway and Transportation Officials ("AASHTO")

3. American Concrete Institute ("ACI")

4. American Institute of Steel Construction ("AISC")

5. Association of Iron and Steel Engineers ("AISE")

6. American National Standards Institute ("ANSI")

7. American Society of Civil Engineers ("ASCE")

8. American Society of Heating, Refrigeration, and Air Conditioning Engineers ("ASHRAE")
9. American Society of Mechanical Engineers ("ASME")
10. American Society of Nondestructive Testing ("ASNT")
11. American Society of Testing and Materials ("ASTM")
12. American Water Works Association ("AWWA")
13. American Welding Society ("AWS")
14. Avian Power Line Interaction Committee ("APLIC")
15. Code of Federal Regulations ("CFR")
16. Concrete Reinforcing Steel Institute ("CRSI")
17. Crane Manufacturer Association of America ("CMAA")
18. United States Environmental Protection Agency ("EPA")
19. Federal Aviation Agency, Department of Transportation ("FAA")
20. Federal Energy Regulatory Commission ("FERC").
21. Federal Highway Administration ("FHWA")
22. IAPMO Uniform Plumbing Code
23. Illuminating Engineering Society ("IES")
24. Institute of Electrical and Electronic Engineers ("IEEE")
25. Instrumentation Society of America ("ISA")
26. Insulated Cable Engineering Association ("ICEA")
27. International Building Code ("IBC")
28. International Electrotechnical Commission ("IEC")
29. Applicable state requirements, including State Department of Transportation

30. National Electric Code (“NEC”)

31. National Electrical Contractors Association (“NECA”)

32. National Electric Safety Code (“NESC”)

33. National Electrical Manufacturers Association (“NEMA”)

34. National Electrical Testing Association (“NETA”)

35. National Fire Protection Association (“NFPA”)

36. National Safety Council (“NSC”)

37. North American Electric Reliability Corporation (“NERC”)

38. Occupational Safety and Health Administration (“OSHA”)

39. Post-Tensioning Institute (“PTI”)

40. Scientific Apparatus Makers Association (“SAMA”)

41. Sheet Metal and Air Conditioning Contractors National Association (“SMACNA”)

42. Society for Protective Coatings (“SPC”)

43. Telecommunications Industry Association/Electronic Industries Association (“TIA/EIA”)

44. Underwriter’s Laboratories (“UL”)

45. DNV-OS-C502, Offshore Concrete Structures.

17.0 EXHIBIT 4 – JOB BOOK REQUIREMENTS

Without limiting the information summarized herein, the purpose of this attachment is to summarize the minimum contents of the Job Books to be prepared by Contractor by the date set forth in the Submittal Schedule.

A. Outline of General Job Book:

1. Table of contents

2. Contracting

   a. Copy of Agreement

   b. Copies of Change Orders

   c. Copies of all requests for information, including responses

   d. List of Subcontractors used on the Project

   e. Summary of all work performed by Subcontractors

3. Project Schedule:

   a. Final, actualized Project Schedule, including actual delivery schedule of Owner-Supplied Equipment

4. Contractor plans:

   a. Spill prevention, control and countermeasure plan

   b. Safety Plan

   c. Security Plan

   d. Environmental Plan

   e. Quality Assurance Plan

   f. Project execution plan

5. Health and safety statistics:

   a. Project construction Work hours and statistical information

b. Incident reports, including accidents, thefts, injuries, and near misses

6. Permits:

a. Copies of Owner Permits

b. Copies of Contractor Permits

7. Training:

a. Project construction training records

b. Copies of training manuals

8. Reporting:

a. Plan of the day reports

b. Weekly progress reports

c. Monthly progress reports

9. Forms and certificates:

a. Certificate of Substantial Completion

b. Certificate of Mechanical Completion

B. Outline of Civil Works Job Book:

1. Table of contents

2. Engineering documents:

a. As-built Wind Turbine coordinates

b. Issued for construction drawings

c. As-Built Drawings

d. SWPPP

e. Aggregate job mix formula

3. Product data for permanently-installed equipment and materials (including manuals, data sheets, and warranty agreements), including, but not limited to, geotextile fabric, permanent gates, permanent culverts, block mesh / flexamat (or similar) if used for low-water crossings and other required equipment and materials, as more particularly described in Exhibit A-1 (Scope of Work)

4. Quality assurance documents:

   a. Inspection documentation: roadway, subgrade, drainage structures, road restoration, intersection modification restoration, subgrade and gravel placement

   b. Testing results: sieve analysis, proctors, moisture density, DCP, proof roll, and other required tests set forth herein

   c. Non-conformance and corrective action reports

   d. Photographs of Project Site restoration

5. Forms and certificates:

   a. Certificate of Access Road Completion

C. Outline of Turbine Foundation Job Book:

1. Table of contents

2. Engineering documents:

   a. Final geotechnical engineering report

   b. Issued for construction drawings, including structural calculations

   c. As-Built Drawings, including structural calculations

   d. Foundation rebar shop drawings

   e. Embedment ring shop drawings

   f. Concrete mix design

   g. Grout mix design or product sheet, as applicable

3. Product data for permanently-installed equipment and materials (including manuals, data sheets, and warranty agreements), including, but not limited to, rebar, anchor bolts, embedment rings, curing compounds, joint compounds, crack repair compounds, sealants,

corrosion inhibitors, grout, mill certificates and other required equipment and materials, as more particularly described herein

4. Quality assurance documents:

   a. Inspection documentation: excavation, subgrade, mud mat (seal slab), rebar, anchor cage, grounding, conduit, forms, backfill, concrete placement, grout placement, structural fill [if any]

   b. Testing results: subgrade compaction, crane pad compaction, backfill compaction, concrete strength, grout strength, and other required tests set forth herein

   c. Foundation Inspection Report, as defined herein

   d. Concrete batch tickets and pour logs

   e. Non-conformance and corrective action reports

5. Forms and certificates:

   a. Certificates of Turbine Foundation Completion

D. Outline of Collection System Circuit Job Book

1. Table of contents

2. Engineering documents:

   a. Issued for construction drawings, including Project Collection System Electrical Studies, as more particularly described herein

   b. As-Built Drawings, including Project Collection System Electrical Studies, as more particularly described herein

   c. Bore plan / log

3. Product data for permanently-installed equipment and materials (including manuals, data sheets, and warranty agreements):

   a. Equipment: medium-voltage cabling, fiber optic cabling, junction boxes, splice kits, fiber splice box, [pad-mount / medium-voltage] transformers [if any], low-voltage cabling (between switchgear and transformer) [if any]

b. Materials: not used

4. Quality assurance documents:

   a. Inspection documentation: trench, cable installation, splice inspections (including coordinates of splice locations), terminations, directional boring, junction boxes (including coordinates of cabinets), [pad-mount / medium-voltage] transformer installation inspection

   b. Testing results: compaction, cable jacket integrity, splice backfill, circuit phase verification, partial discharge (if applicable), VLF, OTDR, voltage and phase rotation, and other required tests set forth herein

   c. Energization and commissioning results, including commissioning checklists

   d. Training certifications, including splice training

   e. Tooling calibration records and testing certificates

   f. Non-conformance and corrective action reports

5. Forms and certificates:

   a. Certificate of Collection System Circuit Completion

E. Outline of Project Substation Job Book

1. Table of contents

2. Engineering documents:

   a. Issued for construction drawings

   b. As-Built Drawings

   c. Rebar shop drawings

   d. Concrete mix design

3. Product data for permanently-installed equipment and materials:

   a. Equipment: breakers, transformers (main power, station service, CT, PT), switches, pre-cast trench, surge arrestors, capacitor bank, buswork, control cable, relays, meters, batteries, etc.

b. Materials: reinforcing steel and anchor bolt mill certificates

4. Quality assurance documents:

a. Inspection documentation: foundations and flat work (pre- and post-pour), concrete placement, ground grid, conduit, trench, steel, equipment installation (breakers, bus, switches, transformers), control building, control cable, terminations, cap bank, fencing

b. Testing results: torque records, ground grid resistivity, concrete strength, transformer settings, cable insulation, continuity checks, breaker functions, polarity, relay functions, and other required tests set forth herein

c. Factory testing records, including breakers, transformers, control house, relays, and meters at a minimum

d. Concrete batch tickets and pour logs

e. Energization and commissioning results, including commissioning checklists

f. Training certifications, including welding

g. Tooling calibration records and testing certificates

h. Non-conformance and corrective action reports

5. Forms and certificates:

a. Certificate of Project Substation Completion

b. Certificate of Interconnection Facilities Completion

F. Outline of Interconnection Line Job Book

1. Table of contents

2. Engineering documents:

a. Issued for construction drawings

b. As-Built Drawings

c. Concrete mix design

3. Product data for permanently-installed equipment and materials:

a. Equipment: conductor, OPGW, ground rods

b. Materials: not used

4. Quality assurance documents:

a. Inspection documentation: foundations (pre- and post-pour), concrete placement, grounding, equipment installation (structures, conduit, OPGW), terminations

b. Testing results: torque records, ground grid resistivity, concrete strength, and other required tests set forth herein

c. Concrete batch tickets and pour logs

d. Energization and commissioning results, including commissioning checklists

e. Training certifications, including welding

f. Tooling calibration records and testing certificates

g. Non-conformance and corrective action reports

5. Forms and certificates:

a. Certificate of Interconnection Line Completion

b. Certificate of Interconnection Facilities Completion

G. Outline of Meteorological Tower Job Book

1. Table of contents

2. Engineering documents:

a. Issued for construction drawings

b. As-Built Drawings

c. Concrete mix design

3. Product data for permanently-installed equipment and materials:

a. Network and communication devices, SCADA system, instruments (anemometers, vanes, and other sensors), data logger, cabling, FAA light and other required equipment and materials, as more particularly described herein

4. Quality assurance documents:

    a. Inspection documentation: foundations (pre- and post-pour), concrete placement, grounding, equipment installation (instruments, logger, FAA light, transformer), terminations, operable communications

    b. Testing results: torque records, ground grid resistivity, concrete strength, and other required tests set forth herein

    c. Concrete batch tickets and pour logs

    d. Energization and commissioning results, including commissioning checklists

    e. Training certifications, including welding

    f. Tooling calibration records and testing certificates

    g. Non-conformance and corrective action reports

5. Forms and certificates:

    a. Certificate of meteorological tower completion

H. Outline of O&M Building Job Book

1. Table of contents

2. Engineering documents:

    a. Issued for construction drawings

    b. As-Built Drawings

    c. Concrete mix design

3. Product data for permanently-installed equipment and materials:

    a. All required equipment and materials, as more particularly described herein

4. Quality assurance documents:

    a. Inspection documentation: foundations and flat work (pre- and post-pour), concrete placement, grounding, building system installation, terminations, emergency systems (fire alarm), landscaping, septic, water well [if any]

b. Testing results: torque records, ground grid resistivity, concrete strength, and other required tests set forth in herein

c. Concrete batch tickets and pour logs

d. Training certifications, including welding

e. Tooling calibration records and testing certificates

f. Non-conformance and corrective action reports

5. Forms and certificates:

a. Certificate of O&M Building Completion

I. Outline of Wind Turbine Job Book (One Per Wind Turbine)

1. Table of contents

2. Engineering documents:

a. As-built coordinates

3. Product data for permanently-installed equipment and materials:

a. All required equipment and materials, as more particularly described herein

4. Quality assurance documents:

a. Testing results: electrical wiring, grout properties and other required tests as more particularly described herein

b. Offload inspection checklists

c. Turbine Supplier assembly and erection checklists

d. Wind Turbine grounding testing results

e. Anchor bolt tensioning logs, including 10% inspection

f. Wind Turbine wiring testing results

g. Service lift installation checklist [if applicable]

h. Tooling calibration records and testing certificates

5. Forms and certificates:

   a. Certificate of Wind Turbine Mechanical Completion

18.0 EXHIBIT 5 – MP CONTRACTOR ENVIRONMENTAL REQUIREMENTS

Contractor Orientation Manual Minnesota Power Environmental Policies

June 2023

Minnesota Power Environmental Policy Statement

The people of Minnesota Power are committed to being responsible corporate citizens. We support the concepts of environmental stewardship and believe they are good business. Consistent with this commitment, we will:

Meet all environmental regulatory requirements and company commitments;

Limit the environmental impacts of our activities;

Protect the environment as we carry out our responsibilities;

Stress efficiency, recycling, and pollution prevention;

Demonstrate and promote conservation of land, air, water, and energy resources; and

Advocate for reasonable and practical environmental laws, regulations, policies, and practices;

Strive to continually improve our environmental performance.

Minnesota Power will continue to balance the environmental impact of our activities with our obligations to shareholders, customers, communities, and future generations.

Environmental Emergencies

For environmental emergencies or incidents at Minnesota Power work sites, such as spills, emissions, wastewater or chemicals releases, or air incidents immediately notify Service Dispatch at 218-355-3200, or extension 3200.

Service Dispatch is staffed 24/7 and will contact the appropriate Environmental Staff.

Safety

For Safety and Industrial Hygiene consultation, guidance, and support, contact the Safety and Industrial Hygiene Department at 218-355-3229 or reference the Minnesota Power Contractor Safety and Company Policies Orientation Manual.

Company Policies

For violations of company policies, contact Human Resources at 218-723-3921.

Minnesota Power Environmental Policy

Minnesota Power values environmental stewardship and is committed to operating in an "environmentally responsible manner."

All ALLETE companies are committed to protecting the environment as well as the health and safety of their employees and families, communities, and the public. To ensure such protection, ALLETE companies will fully comply with all applicable environmental and safety laws and regulations. Penalties can be severe against the company as well as individual employees for violating the law. Therefore, it is important for employees to know the applicable environmental requirements before they act.

Contractors are expected to abide by the Minnesota Power environmental stewardship philosophy. Identifying and properly managing environmental issues is required by contracts and purchase orders issued for any work conducted for Minnesota Power.

Contractor Environmental Responsibilities

Minnesota Power is responsible for the actions of its Contractors. Therefore, Contractors must be committed to compliance with all environmental requirements, laws, statutes, regulations, ordinances, and permits. Throughout this document, Minnesota Power is communicating its expectations for all Contractors on environmental matters. Minnesota Power will hold its Contractors responsible for environmental compliance and for the prevention of environmental incidents during the performance of contractor duties.

Minnesota Power must report each year how much hazardous waste is generated at each of its facilities. Included in those totals are wastes generated by Contractors performing work for Minnesota Power. Proper management and accurate reporting are essential for completing these reports.

Specific Responsibilities

Designated Minnesota Power Representative

The Minnesota Power Project Manager will be the contract representative. Members of Minnesota Power's Environmental and Land Management Department, as well as on-site employees with environmental compliance responsibilities, can also be contacted for questions related to proper management of environmental issues.

Minnesota Power

Minnesota Power will manage the disposal of all industrial and hazardous wastes generated at the work site unless the contract specifically states that the Contractor will have this responsibility. This includes the disposal of all spill clean-up materials.

Minnesota Power has the right to audit the work site and work activities at any time to determine compliance with all the environmental requirements of the project.

Minnesota Power must pre-approve any landfill, disposal site, recycling facility, or waste handling company prior to any Contractor using any of these services.

The Project Manager shall approve the product inventory and associated waste management plan submitted by the Contractor prior to the start of the work.

Contractor

The Contractor will identify in the "Request for Quote" how it plans to manage any hazardous waste materials at the work site and any wastes the Contractor generates during the work.

The Contractor agrees to train its employees in the environmental aspects of their jobs.

The Contractor shall complete an expected product inventory (including SDS sheets and container size) along with an associated waste management plan prior to the start of the work. The waste management plan shall list all wastes produced as a result of this work along with the roles and responsibilities pertaining to proper management of these materials. The management plan shall list the on-site storage locations for all chemical products and wastes produced.

The Contractor must comply with all local, state, and federal environmental laws, statutes, regulations, ordinances, and permits. This includes but is not limited to any storm water permits in effect at the work site.

In the case where the contract specifies that the Contractor will dispose of wastes generated at the site, these materials may only be disposed at a facility that has been pre-approved by Minnesota Power.

The Contractor agrees to contact the Project Manager or the Environmental and Land Management Department if they have any questions related to the proper management of environmental issues during the project.

The Contractor will notify the Environmental and Land Management Department as well as the Project Manager any time a spill, leak, or release of hazardous substance to the environment occurs (this includes any petroleum product or oils).

The Contractor will clean up any spills or releases at Minnesota Power property that result from any work performed for Minnesota Power. The Contractor will manage the waste material in a manner approved by Minnesota Power.

The Contractor will notify the Environmental and Land Management Department any time a hazardous substance is encountered on the property during the work that was not described in the scope of work for the project. This includes any pre-existing conditions. These materials may include, but not limited to, the following: asbestos, lead paint, subsurface contamination, underground storage tanks, etc. By accepting the work, the Contractor states that they have adequate knowledge to identify these situations when they are encountered.

The Contractor will keep the site clean and organized. All industrial, solid, and hazardous wastes will be properly identified and managed on a continuous basis. At the end of the work, the Contractor will ensure that the site is clear of any industrial and/or hazardous wastes. All waste materials will be properly labeled, stored, and/or located in the pre-approved locations. Contractor will support and assist Minnesota Power in waste management activities as discussed and pre-approved by the contract.

The Contractor will correct, at its own expense, any environmental issues, including environmental violations, brought to its attention by the Project Manager or a member of the Environmental and Land Management Department that the Contractor caused while preforming this work.

The Contractor agrees it will not transport any hazardous wastes without the proper identification, licensing, paperwork, placarding, labeling, and marking of the waste, and without the prior notification and written pre-approval of the Project Manager.

All chemical products and all industrial hazardous wastes must be stored in a manner that will prevent spills or releases of the materials to the environment.

All efforts must be made during the project to prevent the release of chemical products or industrial and hazardous wastes to the air, the ground, or into any surface or subsurface water.

Potential Project Hazards

The following items represent only a partial listing of potential hazards and wastes that might be encountered during a project. Each project is different. Unforeseen hazards and wastes could be present that are not listed here. When in doubt, contact the Project Manager or the Environmental and Land Management Department.

SDS: Contractor shall furnish on the project site Safety Data Sheets for all chemical products.

Storage: Storage of hazardous wastes prior to disposal is regulated by the MPCA. Contractors must comply with these requirements.

Asbestos: Asbestos is found in many commercial products. Prior to any demolition or renovation activities, or dismantling of equipment, an asbestos survey must be performed (discuss with the Project Manager). Only Minnesota Department of Health Certified Personnel may perform asbestos activities. Only Minnesota Power pre-approved landfills may be used for disposal. Contractor must comply with all OSHA, Minnesota Department of Health, NESHAP, and MPCA rules and regulations.

Paint Wastes: Paints may display a characteristic of flammability or be toxic due to the nature of the contents. Certain heavy metals used for paint pigments and other ingredients may cause the paint to become hazardous waste when disposed. Oil and latex based paint wastes are managed jointly as hazardous wastes.

Solvents and Degreasers: Solvents and degreasers may be flammable or may contain ingredients that are considered hazardous. Chlorinated solvents, cleaners, and degreasers are toxic.

Used Oil, Oil Filters, Oily Rags, and Oily Floor Dry: These materials are regulated by the State/MPCA. They may only be disposed/recycled at approved facilities. The Minnesota Power Project Manager will provide direction along with written approval prior to disposal/recycling.

Circuit Boards, Electronic Equipment, and Computer Monitors: Management of these waste materials is regulated by the State/MPCA. Minnesota Power contracts with vendors to recycle these materials. They cannon be placed in a landfill.

Sand Blasting Residues: Sand blasting residues may be hazardous based on the chemical composition of the paint contained in the material. Minnesota Power requires that all paints be evaluated for potential hazardous and lead content prior to any sand blasting activities. If high levels of lead are present, Minnesota Power may consider a different method of paint removal.

Treated Wood: The State MPCA regulates the disposal of treated wood. Open burning is prohibited. Treated wood can only be disposed in an approved industrial waste landfill.

Lead Paint: Project planning needs to include paint samples and analysis to determine the lead content. For outdoor projects, MPCA air regulations apply. OSHA regulations apply to worker exposure. Paint removal methods must minimize and properly manage all wastes.

Parts Washers: Parts washers use two types of cleaners, a petroleum-based solvent, and water based cleaner. Both types must be evaluated for hazardousness when disposed or recycled. Contractors must inform the Minnesota Power Project Manager of their intentions to bring additional parts washers on-site. The Project Manager and/or Environmental and Land Management Department will discuss parts washer locations and waste management requirements with the Contractor.

Cleaning Large Oily Parts and Large Equipment: Operating permits at Minnesota Power facilities, in particular the power plants, do not allow oily wash waters and related oily wastes to be disposed in the ash ponds. These permits are enforced by the MPCA. And such wash waters and wastes must be containerized and properly managed. In general, these wastes can not be disposed in the floor drain system.

Boiler Waterside Chemical Cleanings: Minnesota Power Environmental and Land Management Department personnel will be on site during boiler chemical cleanings. These are complex projects. Project management emphasizes safety and spill prevention.

Recycling Scrap Materials: Minnesota Power recycles waste and scrap materials any time that this activity is possible. Contractors must manage recyclable materials properly. Segregation of scrap materials into Minnesota Power managed containers must be followed when they are available at the job site.

Household Trash and Rubbish: These materials must be properly managed. Do not place these materials in containers designed for specific waste collection (for example – oily rag drums, floor dry drums, or scrap metal containers).

Ash: Ash containers (fly ash, bottom ash) must be free of garbage, scrap, wood, clothing, etc.

19.0 EXHIBIT 6 - MP SITE CONSTRUCTION SPECIFICATION – FENCE

19.1 General

19.1.1 Scope of Supply

The Contractor shall furnish all labor, material (except anchor bolts), tools and equipment as required to complete excavation/auguring, fabrication and placement of fencing as detailed on the drawings or specified in the contract documents. Should any discrepancies or ambiguities be found, the Purchaser shall be notified at once to obtain clarification of the same.

On completion and acceptance of the work, promptly remove all equipment, materials, and supplies from the work area and leave the site in a condition satisfactory to the Purchaser.

(1) Not Used

(2) Items Furnished by Others and Interfaces

(a) None.

19.1.2 Performance and Design Requirements

Performance and design requirements for the chain link fencing are indicated in Article 19.1.4.

19.1.3 Codes and Standards

Not used.

19.1.4 **Materials**

The following materials shall be used:

General	
Component	Material
Concrete	3000 psi/28 days, ASTM C150
Fine and coarse aggregate	ASTM C33
Fabric	9 gauge; 2 inch mesh; aluminum coated ASTM A491; twisted selvage on top, knuckled selvage on bottom
Posts	steel pipe, ASTM F1083 standard weight (Schedule 40)
Line posts	2-7/8 inch OD pipe
Terminal posts (end, corner, and pull)	4 inch OD pipe
Gate posts for swing gate opening less than 10 ft.	4 inch (101.6 mm) OD pipe, 9.10 lb per ft;
Gate posts for swing gate opening 10 ft (4.0 m) to 18 ft (5.5 m) wide	6-5/8 inch (168.3 mm) OD pipe, 18.97 lb per ft
Gate posts for swing gate opening 18 ft (5.5 m) and over	8-5/8 inch (219 mm) OD pipe, 28.55 lb per ft
Gate posts (slide gates) - support post	4 inch (101.6 mm) OD pipe, 9.10 lb per ft
Gate posts (slide gates) - latch post	2-7/8 inch (73.02 mm) OD pipe, 5.79 lb per ft
General	
Component	Material
Gate posts (slide gates) - guide post	2-3/8 inch (60.32 mm) OD pipe, 3.65 lb per ft
Top rail	1-5/8 inch (41.28 mm) OD (Schedule 40) pipe, 2.27 lb per ft
Rail couplings	Sleeve type, 6 inch (152.4 mm) long expansion spring in every fifth coupling
Bracing	Pipe brace same as top rail, with 3/8 inch (9.525 mm) diameter steel rod truss and tightener

Post tops (when barbed wire required at top of fence)	Pressed steel
Privacy slats	California redwood heartwood, 2-3/8 by 3/8 inch (60.32 by 9.525 mm) NOT REQUIRED
Barbed wire	Aluminum coated ASTM A121 Class 2; two 12-1/2 gauge steel wires with 4 point round 14 gauge barbs spaced 4 inches (101.6 mm) apart
Stretcher bars	Steel, 3/16 by 3/4 inch (4.76 by 19.05 mm), or equivalent cross-sectional area
Fabric ties	Bands at end posts and gates, 6 gage aluminum coated wire clips for 14” center to center attachment of fabric to line posts, 9 gage aluminum coated wire clips for 24” center to center attachment to top rail and tension wire
Gate frames	1-7/8 inch (47.63 mm) OD (Schedule 40) pipe, 2.72 lb per ft;
Tension wire	Aluminum coated coil spring wire, 7 gauge

Specific	
General Scope	
The following items shall be furnished and installed under this specification:	
Chain link fence	Yes
Swing gate	Yes
Fence Type	
Height of steel fabric	9 ft (2.1 m)
Overall height of fence	10 ft (2.4 m)
Bracing is required for each gate and terminal post	Y

Fence shall be constructed to include:	Top rail, bottom tension wire, bottom rail, and three strands of barbed wire mounted on 45 degree extension arms
Swing Gates	
Swing gates shall be hinged to swing	180 degrees
Swing gates shall be furnished with	Frames, heavy duty flip latches, keepers, hinges, fabric, braces, padlocks, and three strands of barbed wire

19.1.5 **Approved Manufacturers of Components**

Not used.

19.1.6 **Test Requirements**

Not used

19.1.7 **Technical Attachments**

Not used.

19.1.8 **Supplemental Specifications**

Not used.

19.2 Products

19.2.1 **General**

This article covers the installation and materials requirements for chain link fencing and gates. Fencing shall be provided in the alignment indicated on the drawings.

Any materials found not to be in compliance with these specifications shall be removed and replaced at the Subcontractor's expense.

(1) 02821.2.1.1 Fence Type.

(a) Fencing shall conform to the details indicated on the drawings and as specified in Article 19.1.4. The upper barbed wire strand shall be approximately 12 inches (305 mm) out from the fence and 12 inches (305 mm) from the top of the fabric. Posts shall be set in concrete or in sleeves as detailed

19.3 Materials

All rails, posts, bracing, gate frames, fittings, road gates, guardrail and appurtenances shall be hot-dipped galvanized per ASTM Al 20, Al 23 or Al 53.

19.3.1 **Swing Gates.**

Gates shall be swing type, hinged to swing from closed to open as specified in Article 19.1.4. Opening size, gate height, and location shall be indicated on the drawings. Gate leaves, except those on walk-through gates, shall have intermediate members and diagonal truss rods as required for rigid construction and shall be free from sag or twist. If applicable, gates shall be fitted with vertical extension arms or shall have frame end members extended to carry barbed wire. Joints between frame members shall be made by welding or by means of heavy fittings and shall be rigid and watertight. Truss rods shall not be less than 3/8 inch (9.5 mm) diameter. Gate fabric shall be the same as the fence fabric and shall be attached to frame ends by stretcher bars, bolt hooks, or other mechanical means.

Hinges shall be heavy pattern with large bearing surfaces and shall not twist or turn under the action of the gate.

Latches shall be heavy duty flip type, full gate height, and arranged to engage the gate stop, except single gates less than 10 feet (3 meters) wide may be provided with a forked latch. Latches shall be arranged for padlocking with the padlock accessible from both sides of the gate.

Keepers shall consist of mechanical devices for securing and supporting the free end of the gates when in the full open position. Keepers shall be mounted on 2-7/8 inch (73 mm) outside diameter pipe posts filled with concrete and set in concrete foundations.

Gates shall be installed so that they cannot be removed without disassembly of the hardware. Hardware attachment bolts shall be peened so that removal will be difficult.

19.4 Execution

This article covers the construction of chain link fencing and appurtenances included herein and as indicated on the drawings.

19.4.1 Construction

The installed fence shall conform to the alignment and finish grade indicated. Unless otherwise indicated or specified, all posts shall be plumb and spaced 10 feet (3 meters) apart. Where necessary, the fence grade shall be adjusted to fit the ground contour by slipping the fence fabric links. On steep grades, the posts may be set normal to the slope, provided transition sections are constructed.

Ground surface irregularities shall be graded as required to minimize frequent changes in vertical alignment and to provide a smooth profile for the fence. Clearance below the bottom of the fence shall not exceed 2 inches (51 mm).

The plan and profile of each reach of fence between corner posts, or between corner posts and gateposts, shall be straight. Ground surfaces shall be graded as required to achieve the straight profiles before each reach of fence is installed.

All surfaces of aluminum that will be in contact with concrete or mortar shall be given a heavy coat of coal tar paint.

Where the fencing is supported by a concrete structure, posts shall be set in sleeves that provide at least 1/4 inch (6 mm) clearance all around. Sleeves shall be fabricated from standard weight black steel pipe and hot-dip galvanized after fabrication. Sleeves shall be the lengths indicated on the drawings, but in no case less than 6 inches (152 mm). Sleeves shall be rigidly supported in accurate alignment in the forms and shall be positioned vertically so that approximately 1/2 inch (13 mm) of sleeve is exposed above the finished concrete surface. Posts shall be wedged in accurate alignment, and the annular space between posts and sleeves shall be filled with setting cement. The top surface of the filler shall be finished smooth and shall slope away from the post.

Where posts are set in earth, concrete foundations 6 feet deep shall be provided. If bedrock is encountered, post excavation shall be continued to 18 inches (457 mm) into the rock. Concrete foundations shall be circular in horizontal section, not less than 12 inches (254 mm) in diameter for line posts, and with a diameter not less than the post outside diameter plus 9 inches (229 mm) for terminal and gate posts, except that foundations in bedrock shall be a minimum of 6 inches (152 mm) larger than the outside dimension of the post. Foundations shall extend above the ground surface and shall be crowned approximately 1 inch (25 mm). Each foundation shall be cured for at least 72 hours before further work is done on the post.

Top rails and bottom tension wires/rails shall be installed before the fabric. Top rails shall be furnished in at least 18 foot (5.5 meter) lengths and shall be securely connected to gate and terminal posts. If applicable, tension wires shall be installed approximately 6 inches (152 mm) above grade and shall be attached to each post and securely anchored at terminal and gateposts. Straight runs between braced posts shall not exceed 500 feet (152 meters). A terminal post shall be provided at each change in slope.

Fabric shall be attached to the top rail and bottom tension wire/rail at 24 inch (610 mm) centers and to the line posts at 14 inch (381 mm) centers, all on the security side of the fence. If applicable, barbed wire shall be fastened to each extension arm by internal clips or external fabric ties. Stretcher bars shall be provided at each gate, terminal, and pull post. Each stretcher bar shall be threaded through the fabric and anchored to the post at 14 inch (381 mm) centers by positive mechanical means.

Each gate and terminal post shall be braced by a horizontal pipe brace and an adjustable truss extending to an adjacent line post. Corner posts located where the deflection angle is 10 degrees or greater shall be braced in both directions.

Fabric shall be stretched taut.

If specified in Article 19.1.4, snake guard mesh 18 inches (457 mm) high for substations shall be attached to the outside of the chain link fence as indicated on the drawings. The mesh shall extend 6 inches (152 mm) below the top of the crushed rock surfacing and 12 inches (305 mm) above with a 45 degree bend for the top 3 inches (76 mm). The mesh shall be attached to the fence fabric with

aluminum ties spaced not more than 12 inches (305 mm). One row of ties shall be at the top of the mesh and another row at the bottom of the chain link fabric. A section of mesh shall overlap at least three links of the chain link fabric.

Snake guard shall not be attached to the gates.

19.4.2 **Fence Maintenance**

Fencing constructed under these specifications shall be maintained until final acceptance of the work.

20.0 EXHIBIT 7 – MP ELECTRICAL CONSTRUCTION SPECIFICATIONS – 35 KV COLLECTOR SYSTEM

20.1 General

20.1.1 Location

The [Project Name] Project is located near [Location]. Please refer to "Site Layout" drawing for the project site plan general arrangement and location of the Wind Turbine Generators (WTG).

20.1.2 General Works Description

The Contractor shall perform all Work and supply materials for the installation of the 35 kV underground collector system connecting the WTGs to the substation, including the installation of Owner-furnished equipment and materials. Contractor shall install the underground collector system, low voltage cable between the turbine switchgear and turbine step-up transformer, fiber optic communication system, and other work specified to be completed in accordance with prudent construction practices and in accordance with the Contract Specifications, Material Specifications set forth by the Owner, Drawings and applicable Industry Standards.

The Contractor shall install the 35 kV-class underground collector cable system between the Substation and the new WTGs. This includes trenching, laying and splicing of 35 kV power cables; furnishing and installing ground rods and fiber optic cable; terminating the 35 kV power cables at switch cabinets, GSU transformers, Grounding transformers and at the substation; pulling and terminating the 2000 V cable between the turbine and the turbine step up transformer; terminating fiber optic communication cables at the substation fiber access panel, and the fiber patch panels at the WTG towers. Termination of the fiber optic cable at the splice enclosures located at the switch cabinets and any additional locations as indicated on the drawings and splicing at the meteorological (MET) tower; installing fiber optic circuits for the MET tower; and installing conduits, grounding rods and grounding at switch cabinets. The Contractor shall also test all power and communication cables and systems prior to energizing and commissioning per the Owner requirements, applicable turbine manufacturer requirements, and Industry Standards.

20.1.3 **Contractor Responsibilities - General**

Contractor responsibilities, in general, include the following but not limited to:

- Receive, store in accordance with manufacturer's recommendations, secure, track, and release from inventory Owner supplied equipment. See Section 1.7 for Owner supplied equipment and material.
- Contractor will install all 35kV cable, 1/0 AWG, 4/0 AWG, 350 kcmil, 750 kcmil and 1000 kcmil and Fiber Optic cable. Contractor shall be responsible for unloading, receiving and ensuring that the cable is inspected for damage and maintained throughout the duration of the Project. Excess cable, and scraps, will be returned to Owner. Furnish and install underground cable splices, and install 3-way and 4-way switch cabinets as required by the Drawings.
- Furnish and install all PVC conduit, elbows and fittings required for the switch cabinets, GSU transformers, meteorological tower, and at the substation.
- Conduit bushings shall be installed on all conduits penetrating into enclosures.
- Furnish and install switch cabinet grounding grids including grounding rods.
- Install underground collector system, as specified in the Power Cable Schedule. All 35 kV underground collector feeders must be installed in a triplex formation as defined in the drawings, unless otherwise noted.
- Furnish and install, as required, 35 kV, below ground splices for splicing of long runs of 35 kV cable. Exact number required will depend upon final cable routing.
- Furnish and install all terminal connectors, splices, elbows, fault circuit indicators, etc,for all 35 kV terminations and splices, unless otherwise notified by Owner.

- Furnish and install a fiber optic network as specified in the Fiber Optic Cable Schedule. Each WTG within a string loop will have a fiber optic network connection. The Contractor shall provide all fiber optic cable, inner duct, hand holes, splice enclosures, splice cases, patch panels, miscellaneous splicing materials and other material for the fiber optic network.
- The Contractor shall install the meteorological tower power from Coop 200 amp Meter pedestal located on the edge of Road Right of Way and fiber optic cable between the MET Tower and the nearest WTG as shown on the drawings.
- Furnish, install, and test a ground system at each of the WTGs, switch cabinets, splices, and the 35 kV cable trenching system in accordance with the turbine manufacturers specifications and requirements set forth by the Owner. .
- Test all power cable, fiber optic cable, Owner and Contractor supplied equipment and grounding systems as specified prior to and after installation. See Collector System Equipment Testing Procedure Specification for testing specifics.
- Label all cable and equipment as specified in Section 13.3 .
- Maintain and provide material and equipment submittals, test reports, and receiving reports for Owner's and Contractor's supplied material/equipment.
- Provide and install concrete and other materials as required for road and easement

crossings. Provide necessary equipment to bore under paved or other specified roadways and wetlands.

- Provide and install concrete and rock base and other material for setting 35 kV 4-way switch cabinets and 3-way switch cabinets per the drawings.
- The Contractor is responsible to determine trenching conditions prior to bid submittal.
- Contractor is responsible for terminating 35 kV cables at the switch cabinets, underground splices, Grounding transformers and GSU transformers. The Contractor is also responsible to terminate the low voltage cable at the GSU transformers and at the WTG switchgear.
- The Contractor is responsible for terminating the 35 kV feeders at the Substation.
- Furnish and install ground connections between Cadweld ground plates within the floor of WTG foundation and tower grounding bus including all bare copper and connectors.
- Contractor shall restore terraces, berms and any other site features damaged or impacted by construction activities to as close to original condition as practicable.
- Cable shield shall be grounded at every GSU transformer, switch cabinet, splicing location and every 1250 ft.
- Contractor shall supply and install a trace wire with the inner duct with the fiber optic cable and terminate to ground at splice cabinet and hand hole locations only.

20.1.4 **Period of Performance**

Work shall commence upon either receipt of executed contract or as per instructions by Owner. All work shall proceed in accordance with the approved Project Schedule.

20.1.5 **Owner Provided Services**

Owner shall provide inspection personnel to monitor quality of workmanship, materials, and schedule adherence by Contractor(s).

Owner shall provide technical assistance where possible and coordination between Contractors, engineers, and vendors.

20.1.6 **Construction Schedule**

Contractor shall submit upon Contract award and prior to the start of work, a detailed bar chart type “Project Schedule” for this work.

Contractor agrees to provide management, administration, and control of its own work or the work of its subcontractors, of any tier, that may be required to assure completion of the work in accordance with the milestone dates.

Contractor shall perform and complete each segment of the work in accordance with the approved Project Schedule, unless otherwise accepted, in writing, by Owner.

Contractor shall submit, 30 days prior to cable installation, a cable management plan. Cable plan should optimize location and number of underground splices to minimize cable splices. Cable plan may include additional splices as specified in Cable Splicing. Any such splices must be approved by Owner prior to installation. No more than one underground splice per circuit segment will be allowed.

20.1.7 **Contractor Furnished Materials**

Contractor shall supply all materials as listed below and on the drawings. Any substitutions of materials listed by manufacturer with specific model or part numbers shall be approved by the Owner. All material, equipment and devices shall be UL listed or recognized when available.

- Contractor shall supply all PVC conduit, elbows and fittings required for the routing of the 35kV cable, low-voltage circuits and fiber-optic communication cables. All elbows shall be factory made and shall have a minimum 24-inch radius or as indicated on the drawings. The conduit sizes and locations are per the drawings.
- Contractor shall supply all copper stranded grounding conductors used in each switch cabinet grounding loop. Also, any ground rods, cadweld materials, lugs or clamps and hardware required to connect the grounding conductors to ground pads, ground rods, or other equipment to be bonded shall be required.
- Contractor shall supply all 24 count fiber, loose tube, direct buried in inner duct, as specified in the Fiber Optic Cable Schedule. This also includes all connectors, fusion splices, insert adapters, jumpers, splice enclosures, splice cases, and patch panels required to provide a complete fiber optic communication system. Contractor shall supply all Fiber optic cable. Cable Specification shall be used when specifying and purchasing fiber optic cables.
- Contractor shall supply all material equipment and devices shall be UL listed when such listing is available.
- Contractor shall supply all copper conductor and connectors between the WTG Cadweld foundation grounding plates and the WTG tower grounding bus.
- Contractor shall supply all crushed gravel and concrete required to install switch cabinets.

All concrete barrier posts and concrete or crushed gravel required around the switch cabinets shall be supplied by the Contractor.

- The Owner shall supply all 35 kV outdoor above ground 4-way and 3-way switch cabinets.
- The Owner shall supply all GSU transformers.
- The Owner shall supply Grounding transformers
- The Owner shall supply 35kV EPR cable
- Fiberglass basement for switch cabinets

20.1.8 Responsibility for Equipment and Materials

During performance of the Work, the Contractor is responsible for the security, protection from the weather (if needed) and proper storage of all related equipment and/or materials that the Contractor supplies as part of the performance of the Work until turnover and acceptance of the Work by the Owner.

The Contractor shall also be responsible for the security, protection from the weather (if needed) and proper storage of the Owner supplied materials when given to the Contractor for installation or use within the Contractor's scope of work.

20.1.9 Material Delivery and Receiving

The Contractor shall provide the necessary equipment and personnel required to unload, store and protect materials delivered to the jobsite. The contractor shall provide a crane to load and unload GSU transformers. The Contractor shall take all precautions necessary to protect materials from soiling, disfigurement or damage when unloading.

The Contractor shall promptly inspect material shipments to determine product quantity, type, and compliance with material purchase orders.

The Contractor shall record and catalog all received material; if required notify the Owner that the materials were received and condition when received. After inspecting and receiving, the Contractor shall turn over signed bills of lading or packing lists to Owner. The condition of materials received must be noted.

Materials and equipment shall be stored with seals and labels intact and visible for easy retrieval and inspection at a later date. All materials and equipment shall be stored per manufacturer's instructions. Unlike materials shall not be stacked.

The Contractor shall supply tarps, enclosures, heaters, or any other devices to prevent materials and equipment from being damaged by sun, rain, snow, dust or other deleterious conditions.

The Contractor shall supply facilities to store sensitive products in a weather tight, climate controlled environment, if required.

20.1.10 **Equipment Retrieval and Distribution**

The Contractor shall maintain adequate material tracking records to determine their status. When materials are to be distributed to work areas, the Contractor shall provide equipment and personnel to load and transport equipment and materials to their point of use.

The Contractor shall immediately notify the Owner if Owner supplied materials or equipment are misplaced or damaged. When Owner supplied materials or equipment is removed from the storage site for use, the Contractor shall notify the Owner that the materials or equipment are no longer being stored at the storage site.

20.1.11 **Drawings**

(1) General Requirements

The Contractor will receive three sets of construction drawings and specifications. The Contractor shall be responsible for documenting authorized as-built conditions, clearly showing where construction activities differ from the information provided, on one set of drawings. The as-built drawings shall be submitted to Owner after acceptable completion of activities covered by this specification. All work will not be considered complete until as-built drawings have been received and accepted as accurate. Additional sets of drawings will be furnished as requested at the cost of reproduction and handling.

(2) Scaling and Dimension

In reading sizes, distances, angle, slope, and other measurements on maps or drawings, the values used shall be those given in dimensions and figures and shall not be obtained by scaling. When no value is given, dimensions obtained by scaling shall be field verified.

(3) Construction Documentation

In addition to the as-built requirements in General Requirements above, the Contractor shall provide GPS coordinates for cable trenches at all turns, intersections and at every 400 ft. of straight run. All buried splices, grounding locations. and switch cabinet GPS coordinates shall be supplied and clearly indicated on a spreadsheet or the drawings. GPS coordinates supplied on the as-built drawings shall have horizontal accuracy within one meter.

20.1.12 **Cooperation with Others**

The Contractor shall fully cooperate and coordinate with other contractors and manufacturers who may be awarded other work. The Contractor shall exchange with the various contractors and manufacturers all necessary drawings, dimensions, templates, or other information to insure the complete and proper installation of connections or related parts of the wind farm collector system. The Contractor shall not commit or permit any act which will interfere with the performance of work by other contractors. No extra compensation shall be claimed because of any modifications required to accommodate equipment of other manufacturers, except as otherwise specifically stated herein. All adjustments shall be made between the respective contractors without involving extra cost to the Owner.

20.2 Collector System Construction Details

20.2.1 General

The Wind Project is a wind generating facility consisting of [Number] [Number MW] [OEM] turbines. The individual wind turbine generators (WTG) are connected to a 35 kV collection system to form an integrated power generation facility.

20.2.2 Installation Requirements

The Contractor shall perform all Work including installation of the underground collection system, fiber optic communication system, grounding and other work specified in accordance with prudent construction practices, applicable industry standards, and in accordance with the Contract Specifications, Drawings, and Appendixes. The conduits into the WTG are by others.

20.2.3 Codes and Standards

Unless noted to the contrary, all equipment, materials, and labor shall be furnished in accordance with the applicable sections of the latest revision of the following:

- American National Standards Institute (ANSI)
- American Society for Testing and Materials (ASTM)
- Institute of Electrical and Electronic Engineers (IEEE)
- Insulated Cable Engineer Association (ICEA)
- Underwriter's Laboratory (UL)
- National Electrical Manufacturer Association (NEMA)
- National Electrical Code (NEC)
- National Electrical Safety Code (NESC)
- The American Aluminum Manufacturer's Association (AAMA)
- National Electrical Testing Association Inc. (NETA)

20.2.4 Cable Installation General Requirements

The Contractor shall optimize cable usage to minimize cable waste and the number of cable splices

The collection system cables to be installed include 1/0 AWG, 4/0 AWG, 350 kcmil, 750 kcmil, 1000 kcmil 35 kV cable, and fiber optic cable. All cable shall be installed direct buried in a prepared trench. The fiber optic cable shall be blown or pulled into the inner duct and installed in the same trench as the 35 kV power cables as directed. The configuration of the cables and fiber optic conduit is shown on the applicable Drawings.

The contractor shall mark each cable end for identification during installation. Red tape shall identify phase A, White tape shall Indentify Phase B and Blue tape shall identify Phase C. Phase A shall start or terminate at the substation breaker that is identified as phase A. Phase B shall start or terminate at the substation breaker that is identified as phase B. Phase C shall start or terminate at the substation breaker that is identified as phase C. The cables entering a GSU shall be terminated on the following bushing in the GSU. The phase A cable shall terminate on the H1A bushing. The phase B cable shall terminate on the H2A bushing. The phase C cable shall terminate on the H3A bushing. On the switches the A phase cable shall terminate on the top bushing, the B phase cable shall terminate on the center bushing, and the C phase cable shall terminate on the bottom bushing. All construction shall be done in a thorough and workmanlike manner in accordance with the collection system location and routing plans, specification, construction drawings and details, and applicable industry standards.

20.2.5 **Cable and Conduit Routing and Terminal Points**

The Contractor shall generally route cable and conduit as per the 35 kV collection system drawings. The Contractor shall determine, and the Owner shall approve, the exact cable routing. When practical, the cable trench shall be routed in a straight line, shortest distance, between terminating equipment and alongside WTG strings, preferred route is opposite WTG Tower doors. Cable shall not be routed through compacted fill areas or crane pads located around WTG towers except to terminate through an individual GSU transformer. The Contractor shall repair any ground wires, communication circuits or other utilities damaged by the Contractor during trenching or other excavation.

Paralleled single-circuit power cables shall be separated as per the drawings to avoid reduction in cable ampacity due to mutual heating.

The Contractor shall terminate the cables at the 35 kV 3-way and 4-way switch cabinets and GSU transformers as shown in the drawings. The Contractor shall leave sufficient cable slack to allow installation of elbows and termination of the cable to the appropriate switch cabinet or GSU transformer and permit ready disconnection of the elbows and mounting on the parking stands. Wherever feasible, excess slack shall be provided to allow for re-termination in the event of failure. Cables shall be routed through appropriately sized PVC conduit per the detail drawings

The Contractor shall ground the 35 kV cable shield every 1,250 feet using a 3M Grounding Kit sized for the cable run per the detail drawings. Ground cables shall be terminated with 2-hole compression lugs and connected to the ground bus supplied with the switch cabinets and WTG switchgear / GSU transformers. If no ground bus is supplied by the Vendor, the Contractor shall supply a ground bus capable of terminating all shield grounds and pigtails to the grounding grid or ring. Grounding connections at switch cabinets and WTG switchgear / GSU transformer shall be bolted to facilitate separation of grounds for continuity testing and ground mat testing.

20.2.6 **Handling of Cable**

Cable shall be handled carefully at all times to avoid damage, and shall not be dragged across the ground, fences, or sharp projections. Care shall be exercised to avoid excessive bending of the cable. The ends of the cable shall be sealed at all times against moisture with suitable end caps. Where it is necessary to cut the cable, the ends shall be terminated or re-sealed immediately after the cutting operation. Cable damaged by Contractor mishandling shall be replaced by the Contractor at its expense.

20.2.7 **Trenching**

(1) General

The Contractor shall perform all trenching as required to install the power, communication and grounding cables as shown in the drawings. Details concerning depth, backfill and arrangements are shown in the drawings. Permission for deviations from the details shall be obtained from the Owner by the Contractor prior to installation. It is assumed that as the project progresses, the Contractor may want to alter the cable routing as shown on the drawings to avoid obstructions, rock beds or other unforeseen obstacles. Any major deviations from the routings shown on the drawings shall be discussed with the Owner's representative prior to implementing any changes. When the routings deviate from the drawings, the Contractor shall prepare as-built drawings for future reference.

(2) Crossings

In many cases, the cables will cross roads, wetlands, pipe lines, and easements. Most major restricted crossings are shown on the cable layout drawings. However, if additional restricted crossings are encountered, the Contractor shall be responsible to secure or have the Owner secure any permits required and the Contractor shall meet any restrictions required for the crossing in the permit. When cables cross WTG access roads, the Contractor shall schedule trenching with other contractors to prevent disruption of work by the other contractors.

(3) Difficult Digging

If rock or other difficult digging is involved, the Contractor shall determine nature and extent of the difficulty, and the Contractor along with the Owner will determine whether rerouting, rock trenching, or other changes are necessary. Loose soil or crumbling rock will not be considered as "difficult digging". The trench widths specified are minimum values and should be increased as necessary to obtain required depths in loose soils.

(4) Trench Width and Depth

All excavations shall be measured from the final official grades and/or benchmarks. Minimum excavation depths and widths shall be as specified in the construction drawings and/or as specified in these technical specifications. Excavation shall be made to provide the ultimate minimum cover specified in the trench detail drawings. Trench bottoms shall be level, flat and without surface irregularities, and shall be clear of rock and debris.

(5) Cable and Trench Markers

Utility markers shall be placed in the fence line of road crossings and as directed by Owner's representative.

The 35 kV power cable and duct for the fiber optic cable shall be placed in the trench as soon after trenching as feasible. Wherever possible, the power cable and conduit for the fiber optic cable shall be played out from a reel mounted on a moving vehicle or trailer. The reels shall be supported so that they can turn easily without undue strain on the cables. The power cable and conduit for the fiber optic cable placement shall be done under constant supervision to be certain that no damage to the cables occurs.

(6) Cable Visual Inspection

The power cable and fiber optic cable shall be inspected carefully as it is removed from the reel in the laying operation to be certain that it is free from visible defects. The Owner shall decide upon corrective action when defects are discovered.

(7) Power Cable Configuration

The 35 kV power cable shall be laid in a triplexed configuration. In order to keep the cables in this configuration during laying and back fill, the cables shall be secured with cable ties at 5-foot intervals or be bound with a spiral binder. The Contractor shall obtain approval by the Owner if a binding method or other installation method other than cable ties is utilized. Refer to trench drawings for details.

If cable ties are used, proper tie-wrap tools shall be used to prevent over-tightening of the cable tie.

(8) Erosion Control

In the case of trenching on slopes, erosion control measures shall be implemented. Contractor shall contact Owner for direction on any slopes in question. Owner shall approve erosion control measures prior to construction.

(9) Impact on Agricultural Activity

In agricultural areas (wheat, hay, and other actively farmed fields), Contractor shall ensure all areas impacted by trenching operations are free of rock to a depth of 18- inches.

20.2.8 **County and Private Road Crossings**

(1) Paved Road Crossings

Power cables shall be installed by typical trenching methods to cross the roadway. For cables routed under paved roads, the cable shall be installed in the same configuration as shown on construction trench detail drawings and at a maximum depth of 8 feet when acceptable to the authority having jurisdiction over the road. Thermal flowable backfill may be required when depths exceed 8 feet. Contractor shall verify all depths exceeding the typical trench configuration indicated on the detail drawings prior to installation. OSHA approved warning tape shall be installed as detailed in the drawings. The Contractor shall obtain all necessary permits before commencing work.

The Contractor shall prepare drawings or sketched details of the cable crossing as part of the permit application. The Contractor shall be responsible for applying and securing any and all permits and permit payments and/or application fees. The Contractor shall obtain approval of the Owner of all crossing construction methods.

(2) Fiber Optic Cable Crossings

In addition to the 35 kV power cable crossings, paved road crossings are required for the fiber optic communication cables.

The fiber optic cable innerduct shall be installed under the roadway by typical trenching methods. The fiber optic cable shall be routed through 2-inch HDPE innerduct.

The Contractor shall obtain all necessary permits before commencing work. The Contractor shall prepare drawings or sketched details of the cable crossing as part of permit application. The Contractor shall be responsible for all permit payments and/or application fees.

(3) Other Road Crossings

Power cable may cross under other paved, gravel or dirt roads in other locations. For cables routed under gravel or dirt roads, cable and conduit shall be installed in the same configuration as shown on construction trench detail drawings and at a maximum depth of 8 feet when acceptable to the authority having jurisdiction over the road. Thermal flowable backfill may be required when depths exceed the typical configurations indicated on the drawings. Contractor shall verify all granular road crossing depths prior to installation. OSHA approved warning tape shall be installed as detailed in the drawings. Disturbed portions of the roadway shall be restored to original condition. The backfill shall be made in 6-inch lifts and mechanically tamped and packed, and the last 12-inches of the backfill shall be of stable 3/4-inch minus crushed rock or gravel. Care shall be taken not to damage cable during compaction of gravel. The Contractor shall obtain any and all permits, for each county road crossing before commencing work. The Contractor shall prepare drawings or sketched details of the cable crossing as part of permit application. The Contractor shall be responsible for all permit payments and/or application fees.

20.2.9 **Easement Crossings**

The collection system cables and conduits may cross existing power, communication, and gas line easements in several locations. All existing lines shall be located and exposed by hand. The Contractor shall contact the Owners of existing utilities and obtain approval and any permits required. The Contractor shall take care in making cable crossings to avoid damage to underground utilities. Owner will review and approve any special installation requirements due to crossing easements.

20.2.10 **Fence and Irrigation Pipeline Crossings**

The Contractor shall take reasonable care in locating and identifying crossed facilities such as fences, drain tiles, domestic water lines, and irrigation pipeline. The Contractor shall notify land owner, take reasonable care in crossing land owner's facilities and shall be responsible for damages and repairs to all facilities. The Contractor shall return crossed surfaces to "as found" conditions.

20.2.11 **Streams and Wetland Crossings**

The Contractor should be aware that several of the underground cables cross or will impact intermittent or permanent streams or other wetland features that may require the Contractor to follow procedures or restrictions by federal, state and county agencies that regulate streams and wetlands. It is assumed that wetland crossings will utilize an open trench method of construction. The Contractor shall verify with the Owner the type of construction allowed.

(1) Work Window

If intermittent streams are flowing at the time the project commences, work in and around intermittent streams may be restricted until surface waters are no longer flowing.

(2) Erosion Control

All practicable erosion control devices shall be installed and maintained in good working order throughout construction to prevent the unauthorized discharge of material into a wetland or tributary. The devices shall be installed to maximize their effectiveness, e.g. sediment fences shall generally be buried or similarly secured. These controls shall be maintaineduntil permanent erosion controls are in place.

Practicable erosion control measures include, but are not limited to the following:

- Fill is placed in a manner that avoids disturbance to the maximum practicable extent (e.g. placing fill with a machine rather than end-dumping from a truck).
- Prevent all construction materials and debris from entering waterway.
- Use filter bags, sediment fences, sediment traps or catch basins, silt curtains, leave strips or berms, Jersey barriers, sand bags, or other measures sufficient to prevent movement of soil.
- Use impervious materials to cover stockpiles when unattended or during rain event.
- Erosion control measures shall be inspected and maintained daily to ensure their continued effectiveness.
- No heavy machinery in a wetland or otherwaterway.
- Use a gravel staging area and construction access.
- Fence off planted areas to protect from disturbance and/or erosion.
- Flat or fence off wetlands adjacent to the construction area.

(3) Restoration

Where trenches cross intermittent streams, the topsoil from the trench shall be temporarily stockpiled on-site. After cables are installed in the trench, the trench shall be filled to pre-construction conditions with the stockpiled top soil and reseeded with native grasses if the crossing is not tilled for farming.

(4) Horizontal Directional Drilling (HDD)

In most cases, restriction by Federal, State and/or County agencies may require that the cables be installed by HDD to prevent disturbing permanent streams. The Contractor shall follow all restrictions and obtain any permits for crossing or drilling under any permanent streams.

The specific areas utilizing HDD shall be determined by the local authority. The minimum boundaries for HDD's shall be the high water marks of the stream/wetland. The contractor shall contact the Owner prior to constructing any horizontal directional drills.

20.2.12 **Archeological and Sensitive Animal Species Sites**

The Contractor shall avoid all archeological and sensitive animal species sites. When construction activities approach these areas, archeological site setback boundaries shall be located and clearly marked. The Contractor shall be responsible to ensure that the area within the setback boundary is not disturbed by any of the construction activities.

20.2.13 **Backfill with Select Native Material**

The bedding and padding backfill material for the trench shall be excavated free of rocks (no rocks larger than what would pass through a number 4 screen) and free of wood, roots, vegetable matter, or other deleterious material. Four to six inches of bedding material shall be placed into the trench before the 35 kV power cables and fiber optic innerduct are placed in the trench. The cable depth when laid on the bedding material shall be a minimum of 42-inches below the finished grade. Refer to drawings for cable depths.

Approximately twelve inches of padding shall cover the cables and be compacted to approximately 12- inches to no less than 90 percent proctor or 105 pcf. Compaction shall be by proven methodology. Test reports of backfill from previous projects using the same methodology to be used in this project may be submitted to prove methodology. Field testing of trenches shall be conducted using approved test equipment to prove methodology. Test reports of trench compaction shall be submitted to Owner for every 1000ft of trench. Testing of trench compaction shall be performed by Contractor under direction of Owner's representative at random locations throughout the project. Test reports of trench compaction shall be submitted to Owner.

The fiber optic cable shall be placed at the same elevation 12-inches from the 35 kV power cable

In cultivated fields the OSHA approved warning tape shall be laid on the compacted level 30-inches below finished grade. The remaining 30-inches of the trench shall then be backfilled over the warning tape. In other areas the warning tape may be installed at 18" below final grade. Final backfill material shall be compacted to eliminate voids with additional backfill added to allow for settling.

20.3 Cast-in-place Duct Bank Concrete and Fluidized Thermal Backfill

20.3.1 **General**

This section covers all concrete and fluidized thermal backfill (FTB) for the Collector System and includes reinforcing steel, forms, finishing, curing, and other appurtenant work.

20.3.2 **Scope of Supply**

Scope of supply shall include furnishing and placing concrete and reinforcement, constructing required formwork, and furnishing materials, equipment, and labor to complete the concrete and FTB work including other services as specified herein.

20.3.3 **Mix Design Submittals**

The source and quality of concrete materials and the concrete proportions proposed for the Work shall be submitted to the Purchaser for acceptance before the concrete work is started. Complete certified reports covering the materials and proportions shall be prepared by the Subcontractor's independent testing laboratory and submitted to the Purchaser. Review of these reports will be for general acceptability only; continued compliance with all subcontract provisions will be required.

A tentative mix shall be designed and tested in accordance with ACI 318 and/or other applicable methods for each mix specified. Design quantities and test results of each mix shall be submitted for review.

Acceptable mixes shall be subject to field adjustment as necessary to meet the requirements of these specifications.

Reports for each FTB or concrete mix design shall contain the following information:

- Compressive Strength and Slump on which design is based.
- Description of Materials.
- Cement content.

- Fly ash content.
- Total gallons of water per cubic yard.
- Water-cement Ratio.
- Ratio of fine to total aggregates.
- Weight (surface dry) of each aggregate per cubic yard.
- Quantity of each admixture.
- Air content.
- Slump
- Compressive strength based on 7 day and 28 day compression tests.
- Times of initial set.
- Thermal resistivity if required

Thermal mix designs (fluidized thermal backfill and thermal duct bank concrete) shall be coordinated with Geotherm, Inc. or approved equal to ensure the design thermal resistivity (Rho) is acceptable.

Nimesh Patel / Geeta
Parmar GeothermUSA

6354 Clark Ave

Dublin, CA 94568

Telephone (925) 999-9732

In addition to the normal testing, two compression test cylinders shall be made from each design mix of the thermal concrete described in the article titled **Limiting Requirements** for the purpose of determining the thermal characteristics of the material. The test cylinder size shall be coordinated with the testing laboratory. The laboratory testing and consultation costs shall be paid by the Subcontractor. Shipping costs shall also be paid by the Subcontractor.

20.3.4 **Limiting Requirements**

Concrete Application	28 Day Strength	Coarse Aggregate Size	Max. Slump	Max. Water to Cement Ratio	Total Air Content	Maximum Thermal Resistivity
Thermal Duct Bank Encasement	4,000 psi Minimum	3/8" to No.4	6" Max	0.45	2% max	50 °C-cm/W at 4% moisture, 100 °C-cm/W at 0% moisture
Flowable Thermal Backfill	300 psi **Maximum**	3/4" to No.4	10" Max	0.75	2% Max	50 °C-cm/W at 4% moisture, 100 °C-cm/W at 0% Moisture

20.3.5 **Controlled Low Strength Materials**

Flowable Thermal Backfill (FTB) is a Controlled Low Strength Materials (CLSM) and should be sampled and tested using methods and procedures specific to CLSM materials as specified by ACI and ASTM.

20.3.6 **Codes and Standards**

Work performed under these specifications shall be done in accordance with the following codes and standards. Unless otherwise specified, the applicable governing edition and addenda to be used for all references to codes or standards specified herein shall be interpreted to be the jurisdictionally approved edition and addenda. If a code or standard is not jurisdictionally mandated, then the current edition and addenda in effect at the date of this document shall apply. These references shall govern the work except where they conflict with the Purchaser's specifications. In case of conflict, the latter shall govern to the extent of such difference:

Work	In Accordance With
Hot weather concreting	ACI 305R
Cold weather concreting	ACI 306R and ACI 301
Building code requirements for reinforced concrete	ACI 318
Recommended practice for concrete formwork	ACI 347R
Splices in reinforcing steel	ACI 318
Tolerances	AISC Manual of Steel Construction, Code of Standard Practice, ACI 117, ACI 301
Finishes and finishing	ACI 301
Sampling and Testing for Strength	ACI 318, Section 5.6
Preparation and Testing of Controlled Low Strength Materials (CLSM) Test Cylinders	ASTM D 4832
Sampling Freshly Mixed Controlled Low Strength	ASTM D 5971

Work	In Accordance With
Material	

20.3.7 **Materials**

Materials shall be in accordance with the following requirements:

Cement	ASTM C150, Type I, II or V.
Fly Ash	ASTM C618, Type C or F
Fine aggregate	Clean natural sand, ASTM C33 including Appendix XI. Manufactured sand will not be acceptable.
Coarse aggregate	Crushed stone, washed gravel, or other acceptable inert granular material conforming to ASTM C33 including Appendix XI, class designation 4S.
Water	Potable, free from deleterious substances. Iron shall not exceed 0.25 ppm.
Admixtures	
Plasticizer, water reducing	ASTM C494, Type A
Air-entraining agent	ASTM C260
Plasticizing retarder	ASTM C494, Type D
Reinforcing Steel	
Bars not otherwise noted	ASTM A615, Grade 60. Yield strength shall be determined by full size bar tests.
Bar supports	CRSI Class 3 where in contact with formed surfaces that will not be exposed. CRSI Class 1 plastic protected for use in contact with forms for exposed surfaces.
Welded wire fabric	ASTM A185 or A497
Mechanical splices	Erico products "Cadweld" or approved equal.
Fibrous reinforcement	Fibrillated polypropylene, minimum tensile strength 70,000psi, application rate 1.6 lb/cy, manufactured by FORTA Corp., Ph. (800) 245-0306 or acceptable equal.
Water stops	

Flexible	PVC ribbed or serrated, 9 inches by 3/8 inch, with "0" bulb closed center sections unless otherwise indicated on the drawings.
Forms	
Prefabricated	Patent's "Mod-U-Form", Symons "Steel Ply", or Universal "Uni-form."
Plywood	Product Standard PS1, waterproof, resin-bonded, exterior type, Douglas fir; face adjacent to concrete Grade B plywood or better.
Fiberboard	Fed Spec LLL-B-810, Type II; tempered, waterproof, screenback.
Lumber	Straight, uniform width and thickness, and free from knots, offsets, holes, dents, and other surface defects.
Chamfer strips	Clear pine, surface against concrete shall be planed.
Form coating	
Nox-Crete	"Nox-Crete Form Coating"
L&M	"Debond"
Protex	"Pro-Cote"
Richmond	"Rich Cote"
Polyethylene film	Fed Spec L-P-378D, Type I; 6 mil
Isolation joint materials	
Filler	Preformed, ASTM D1752, Type I (sponge rubber) or closed cell plastic foam (PVC or polyethylene).
W. R. Grace	"Rodofoam" Grade 300.
Urethane sealant	Two component, Fed Spec TT-S-00227E, Type 1, Class A; gray color.
Primer	As recommended by sealant manufacturer.

Epoxy bonding compound	
Sika Chemical	"Sikadur Hi-Mod"
Membrane curing compound and floor sealer	Styrene-acrylate or styrene-butadiene; ASTM C309, Type 1, except that it shall have a minimum 18 percent solids, shall be non-yellowing, and shall have a maximum unit moisture loss of 0.039 g/sq cm maximum.

20.3.8 Required Tests

The following testing shall be conducted in accordance with the specified source. Field testing intervals and requirements are specified in Table 1, Concrete Field Testing Requirements at the end of this section.

All tests shall be performed by an independent testing laboratory (Laboratory). The independent testing laboratory shall be contracted by the entity identified below as conducting the test.

This testing is to be considered part of the defined Scope of Work, and all associated costs are the responsibility of the Subcontractor unless specifically identified as a Bid Option or Purchaser-conducted. Tests identified as an option are to be priced separately. If a test is identified as Purchaser-conducted, costs for the initial test will be the responsibility of the Purchaser. However, the Subcontractor is responsible for all costs associated with correcting deficiencies and retesting in the event of a test failure:

Tests	In Accordance With	Conducted By
Sampling Concrete	ASTM C172	Contractor
Sampling CLSM	ASTM D5971	Contractor
Slump test	ASTM C143	Contractor
Air content	ASTM C231	Contractor
Concrete test cylinders	ASTM C31	Contractor
FTB test cylinders	ASTM D 4832	Contractor
Compression test	ASTM C39	Contractor
Compression strength test	ACI 318, Chapter 5	Contractor
Concrete temperature	ASTM C1064	Contractor
Concrete thermal resistivity	IEEE STD 442	Contractor

20.3.9 Material Control Testing

The following tests and the test reports shall be performed during the progress of the work. Material control testing shall be repeated for any change in material source.

Aggregate gradation - Sampling and testing shall occur as specified in this Specification and at least every month.

Supplementary cementitious materials (fly ash, ground granulated blast furnace slag, silica fume) - Certified copies of Supplier's (source) test reports showing chemical composition and physical analysis for each shipment shall be provided to the Purchaser. The certification shall confirm compliance with the specifications. The certificate shall be signed by the mineral admixture supplier.

Cement - Certified copies of Supplier's (source) test reports showing chemical Certification shall show that the cement complies with these specifications. The certificate shall be signed by both the cement manufacturer and the Supplier.

20.3.10 **Limiting Requirements**

Unless otherwise specified, each mixture shall be designed and controlled, within the following limits, to provide a dense, durable suitable for the expected service conditions.

Each mixture shall be designed and concrete shall be controlled within the limits specified.

20.3.11 **Cement Content Limits**

The minimum quantity of Portland cement or combined Portland cement and mineral admixture in the product shall be as specified below.

Maximum cement content, when Type I cement is used, shall not be more than 1.15 times the minimum cement content specified. When a Type II or Type V cement is used, the cement content shall not be increased more than necessary to achieve the required compressive strength average (f'cr).

20.3.12 **Maximum Water-Cementitious Material Ratio**

The maximum water-cement ratio shall be determined on a cement mass basis. If fly ash is used, the combined mass of cement and pozzolan shall be used to determine the water-cementitious materials ratio.

20.3.13 **Supplementary Cementitious Materials**

When included in structural concrete, supplementary cementitious material shall be within the following percentages of the combined weight of cementitious material:

Fly ash	15 to 25 percent
Ground granulated blast furnace slag	15 to 50 percent
Silica fume	7 percent max

Ground granulated blast furnace slag and silica fume are not acceptable in thermal concrete mixes. Fly ash is acceptable as an admixture.

20.3.14 **Aggregates**

Fine aggregate shall be clean, natural sand. Artificial or manufactured sand will not be acceptable. Coarse aggregate shall be crushed rock, washed gravel, or other inert granular material.

Final gradation of the coarse aggregate shall conform to maximum nominal size grading requirements of the referenced standards when one size of aggregate or a combination of two or more sizes is used.

The maximum coarse aggregate content consistent with workability and minimizing shrinkage shall be used in the mixture.

20.3.15 **Ratio of Fine to Total Aggregate**

The ratio of fine to total aggregates, based on solid volumes (not weights), and shall be as follows:

Coarse Aggregate Size from No. 4 (4.75 mm) Sieve to	**Ratio**	
	Minimum	**Maximum**
3/4 inch (19 mm)	0.35	0.50

20.3.16 **Slump**

FTB and thermal concrete slumps shall be kept as low as possible, consistent with proper handling and thorough consolidation.

20.3.17 **Initial Set**

The initial set shall be attained 5-1/2 hours ±1 hour after the water and cement are added to the aggregates for each concrete mixture. The quantity of retarding admixture shall be adjusted to compensate for variations in temperature and job conditions.

20.3.18 **Total Air Content**

The total volumetric air content of structural concrete after placement shall be within ±1.5 percent of the specified value.

Thermal mixtures have maximum allowed total air content. The total air content of thermal mixtures shall not exceed the specified values.

20.3.19 **Chemical Admixtures**

Unless otherwise acceptable to the Engineer, all chemical admixtures shall be from one manufacturer and shall be compatible. Chemical admixtures that are compatible with other admixtures and concrete materials shall not have an adverse effect on the required properties of the concrete nor the specified limiting requirements. The chemical admixture content, batching method, and time of introduction to the mixture shall comply with these specifications and with the manufacturer's recommendations. The chemical admixture manufacturer shall provide qualified field services as necessary, at no additional cost to the Purchaser.

Chemical admixtures used in the concrete shall minimize shrinkage and shall be as recommended in writing by the chemical admixture manufacturer prior to conducting the laboratory trial concrete mixture testing. No calcium chloride or admixture containing calcium chloride shall be used. Chemical admixtures containing unrefined or raw lignosulfonic acids ("lignins") or their salts will not be acceptable.

Combinations of chemical admixtures which cause premature or local dehydration or post-compaction settlement of the concrete surface shall not be used.

When chemical admixtures are used in large dosage rates [10 oz (283 g) or more per 100 lb (45 kg) of cementitious material], their water content shall be included in the total unit water content.

20.3.20 **Pumped Concrete**

Coarse aggregate size for pumped concrete mixtures shall be limited to a maximum of 1-1/2 inches (37.5 mm).

The slump of concrete, with or without a superplasticizer, that is discharged into the pump may exceed the specified maximum slump value by the amount of slump loss in the pumping system, up to a maximum of 1 inch (25 mm). The slump loss shall be determined by tests made at each end of the pumping system.

20.3.21 **Special Requirements for Hot Weather**

A water reducing retarder shall be included in the concrete mix when the temperature of the concrete placed exceeds 75° F (24° C).

20.3.22 **Strength**

Concrete shall achieve an average strength above the specified design strength provided above in the specification. Statistical data for 28 day strengths and the moving average of three 28 day strengths shall be maintained for each mix.

20.3.23 **Batching**

Aggregates, mineral admixture, and cement shall be measured by weight, or volumetrically blended and calibrated back to weight basis. Aggregate weights shall be adjusted for the moisture content.

Correct proportions of admixtures shall be dispensed automatically.

The amount of water required to produce the desired slump shall be batched automatically. Additional water needed to maintain a uniform slump shall be added manually by the mixer operator at the job site.This additional site-added water shall be limited to a volume that maintains the total mix water to within the volume defined by the maximum specified water-cement ratio for that mix. Slump shall be kept uniform. Aggregates shall float uniformly throughout the mass, showing no segregation. The material shall flow sluggishly when vibrated.

20.3.24 **Mixing**

FTB and concrete shall be mixed until all ingredients are uniformly distributed throughout the batch. Aggregates should be pre-blended prior to addition of Portland cement, water and additives to ensure the highest product uniformity. Mixers shall not be loaded in excess of their rated capacities.

If the mixing water is added at the worksite, only the prescribed amount of mixing water required by the mix design shall be placed in the mixing tank, unless the tank is equipped with a meter allowing the amount of water added to each batch to be verified. If water content does not exceed limiting requirements, water may be added to the product at the discharge point. Only one application of water will be allowed. The water shall be incorporated into the mix by at least 30 revolutions of the truck mixer at mixing speed, or by approved alternative method.

If a high range water reducer (super-plasticizer) is used, slump shall be controlled by the addition of measured amounts of admixture instead of adding water.

20.3.25 **Delivery**

Delivery tickets shall be prepared for each load of FTB or concrete. Tickets shall be presented to the Site QA Manager receiving the product to acknowledge receipt. These signed delivery tickets shall be distributed as follows:

One copy to the Purchasers Representative.

Delivery tickets shall indicate the following:

a. Serial number of ticket.

b. Truck number.

c. Mix class of FTB, concrete or grout.

d. Quantity delivered (include weights of constituent materials)

e. Date and time of delivery.

f. Outdoor temperature in the shade.

g. Time when cement was combined with water or wet aggregates. Design slump

h. Numerical sequence of delivery.

i. Time of FTB or concrete discharge from the truck and time when the truck is released after discharge.

j. Quantity and type of admixtures.

k. Site dispensed admixtures and volume dispensed.

l. Allowable water permitted after batch water added, and quantity of extra water added.

m. Percent moisture compensation for each type of aggregate. Both "heated" or "cooled" FTB or concrete checkoffs.

n. FTB or concrete temperature at batch plant.

FTB or concrete shall be discharged within 90 minutes or before the drum has revolved 300 revolutions after the introduction of the mixing water to the cement and aggregates, or the introduction of the cement to wet aggregates. In hot weather, or under conditions contributing to quick stiffening of the FTB or concrete, a shorter time period may be required by the Purchaser's Construction Manager. FTB or concrete that does not meet this time requirement may be rejected.

(1) Hot Weather Delivery

FTB or concrete delivered in hot weather shall be in accordance with the recommendations of the codes and standards specified. Hot weather FTB, concrete or grout procedures shall include cooling the mix water, aggregates, and cement; the addition of ice; and other processes to accomplish the work.

FTB or concrete temperature at the time of placement shall not exceed 95° F (32° C). Loss of slump, flash set, and cold joints are unacceptable.

At air temperatures of 90° F (32° C) and above, special procedures shall be used to keep the FTB or concrete as cool as possible during placement.

(2) Cold Weather Delivery

When the average of the highest and lowest temperature during the period from midnight to midnight is expected to drop below 40° F (4° C) for more than 3 successive days, FTB or concrete shall be delivered to exceed a minimum of 50° F concrete temperature.

20.3.26 **Evaluation and Acceptance**

FTB or concrete will be evaluated for compliance with all requirements of the specifications. Compressive strength will be only one of the criteria used for evaluation and acceptance of the product. The results of all tests performed on the FTB or concrete and other data and information concerning the procedures for handling, placing, and curing will be used to evaluate for compliance with the specified requirements.

Evaluation and acceptance shall be on a per batch plant basis. Each batch plant shall require separate testing.

(1) Compression Test Evaluation

Compressive strength test results will be evaluated for compliance with the specified strength requirements and the specified requirements that relate to durability.

A set of 4-cylinders shall be made from the same FTB or concrete sample. One cylinder shall be tested for strength at 7-days, and two cylinders tested at 28 days. When one cylinder does not meet specifications at 28-days, retain the other cylinder and spare for testing at 56-days. The average must meet specifications. If not, core samples shall be taken from the actual in-place material.

(2) Strength of Concrete

When required for compliance with the strength requirement, the strength level of the concrete will be considered satisfactory when the averages of all sets of three consecutive strength tests equal or exceed the specified compressive strength, f'c, and no individual strength test result falls below the specified compressive strength by more than 500 psi (3.5 MPa).

(3) Thermal Resistivity Test Evaluation

Thermal resistivity tests shall be performed on test samples for a representative sample of the material as listed in Table 1. Thermal resistivity tests will be required for mix design approval.

(4) Substandard FTB or Concrete

Thermal materials shall meet the limiting requirements specified. If a test cylinder indicates that the material does not meet these requirements, the material represented by the test shall be investigated at the Purchaser's option. The investigation shall include evaluation of the sampling and testing methods used by the laboratory, as well as sampling and testing of the in-place FTB or concrete to verify the results of the cylinder test. The Subcontractor and Laboratory shall cooperate with the Purchaser's Construction Manager during sampling and testing, and the Subcontractor shall pay all associated costs, including the replacement of FTB or concrete for the samples removed, if in-place testing concurs with cylinder testing.

If the investigation verifies the existence of defective concrete, the Subcontractor shall be responsible for the following as determined by the Purchaser:

The cost of removal and replacement of all defective concrete.

The cost of design and construction changes necessary to incorporate the inferior concrete.

Satisfactory reimbursement or allowance to the Purchaser for the acceptance of the lower quality concrete.

If spare cylinders are available for later age testing, these cylinders shall be used to confirm that the design properties have been achieved. The Subcontractor shall pay for this testing and be responsible for the costs associated with the making and storing of these cylinders.

20.4 Placement of Cast-in-Place Concrete and Fluidized Thermal Backfill

20.4.1 General

Work shall include design and construction of formwork; installation of reinforcing steel and other embedments; concrete placement, finishing, curing and other appurtenant work; and provision of miscellaneous materials and services complete as specified. Concrete reinforcement and embedments are covered in separate sections.

20.4.2 Placement of Steel Reinforcement

Reinforcement shall be accurately positioned and secured in place with wire ties or suitable clips. Bare metal supports shall not be used in contact with forms for exposed concrete surfaces.

The clear distance between individual parallel bars shall not be less than 1.5 times the maximum size of coarse aggregate in the concrete; not less than one nominal bar diameter; and not less than 1 inch (25 mm) in beams, 1-1/2 inches (38 mm) in columns, or 2 inches (51 mm) in other locations. Where reinforcements in beams are placed in two or more layers, the bars in the upper layer shall be placed directly above the bars in the lower layer and the clear distance between layers shall not be less than 1 inch (25 mm). Clear distance limitations between individual bars shall also apply to the clear distance between a contact lap splice and adjacent splices or bars.

(1) Splices

Splices shall conform to the specified codes and standards. Lap splice lengths shall permit all bars to be spliced at the splice location with no reduction in splice length due to staggered splice locations or excess reinforcement unless otherwise indicated on the drawings. Splices in horizontal reinforcement placed in vertical wall sections shall be spliced in accordance with top reinforcement requirements. Splices shall not be used in regions of maximum bending stress.

Lapped splices shall not be used for bars with a diameter greater than 1-1/2 inches (38 mm). Splices for bars with a diameter greater than 1-1/2 inches (38 mm) shall be made with mechanical splices.

Mechanical splices under tension shall develop the minimum strength specified in Article 16838.1.5. The first four splices made by each operator shall be made in the presence of the mechanical splice manufacturer's representative and the Site Construction Manager. Each operator shall make splices in the same splicing positions (vertical, horizontal, angle, or special) to be made for the project. All procedures used shall be acceptable to the mechanical splice manufacturer's representative and the Engineer.

Reinforcing bar splices shall be welded only when directed by the Engineer.

(2) Coatings

Rebar coatings that are damaged during installation shall be repaired as specified by the coating manufacturer's standards.

20.4.3 **Formwork**

Forms shall be designed and constructed to produce hardened concrete having the shape, lines, and dimensions indicated on the drawings.

Vertical surfaces of footings extended above finished grade shall be formed.

(1) Formwork Construction

Forms shall be sufficiently tight to prevent leakage of mortar and shall maintain position, shape, and alignment during and after placement of concrete.

(2) Form Ties

Form ties shall have sufficient strength, stiffness, and rigidity to support and maintain the form in proper position and alignment without the use of auxiliary spreaders. Outer ends of the permanently embedded portions of form ties shall be at least 1 inch (25 mm) back from adjacent outer concrete faces. Permanently embedded portions of form ties that are not provided with threaded ends shall be constructed to allow the removable ends to be broken off by twisting without chipping or spalling the concrete surface. Form ties shall be acceptable to the Purchaser.

Form ties in exposed surfaces shall be uniformly spaced.

(3) Edges and Corners

Chamfer strips shall be placed in forms to bevel all salient edges and corners except buried edges and edges that are designated on the drawings to receive special treatment. Equipment bases shall have formed beveled projecting edges for all vertical and horizontal corners unless indicated otherwise on the drawings. Bevel dimensions shall be 3/4 inch by 3/4 inch (19 mm by 19 mm) unless indicated otherwise on the drawings.

(4) Form Removal

Forms shall not be removed from structures until the concrete in the structure has sufficient strength to support the weight of the structure and any superimposed load, including loads from construction operations. The Subcontractor shall be responsible for limiting any applied loadings. There shall be no evidence of damage to concrete and no excessive deflection or distortion of members due either to the removal of forms or to loss of support.

When forms are removed before the specified curing is completed, measures shall be taken to immediately continue curing. In cold weather conditions, adequate thermal protection for the concrete shall be provided.

20.4.4 **Embedments**

Anchor bolts, castings, steel shapes, conduit, sleeves, masonry anchorages, and other materials embedded in the concrete shall be accurately positioned and securely anchored.

Location tolerances for anchor bolts, and for structural members, embedded structural steel shapes, and plates, shall be in accordance with AISC Manual of Steel Construction Code of Standard Practice.

Tolerances for equipment anchorages shall be as required.

Anchor bolts shall be provided with sufficient threads to permit a nut to be installed on each side of the form or template. The nuts shall secure the bolt in its proper position.

Pipe sleeves, conduit, and other embedments shall be within 1/4 inch of their design locations unless specified otherwise on the drawings or other specification sections.

Embedments shall not be welded to structural reinforcement.

Embedments shall be clean when they are installed. After concrete placement, exposed surfaces of embedments shall be cleaned of all concrete spatter and other foreign substances.

Anchor bolt sleeves, handrail sleeves, and similar openings in concrete susceptible to filling with water and freezing shall be filled with closed cell PVC expansion joint filler for protection until grouting. The upper neck of plastic anchor bolt sleeves shall be cut out and the annular space filled with closed cell PVC expansion joint filler or other means acceptable to the Purchaser.

20.4.5 **Placement**

The handling, depositing, and compacting of FTB, concrete and/or grout shall conform to these specifications. Adjustments may be made by the Purchaser for weather or placement conditions.

The Purchaser shall be notified at least 24 hours in advance of the times and locations where concrete is being placed.

Concrete shall not be pumped through aluminum or aluminum alloy pipe.

Subgrades shall be moistened with water prior to concrete placement. The subgrade shall not contain puddles or wet, soft, unstable or muddy areas when the concrete is placed.

Concrete placed against rock or existing concrete shall have loose pieces of rock removed and the exposed surface cleaned with a high-pressure hose before concrete is placed.

The space receiving concrete shall be clean and clear of debris and standing water, and the entire installation shall be acceptable to the Purchaser’s Construction Manager before concrete is placed.

Surfaces encrusted with dried mortar or concrete from previous placement operations shall be cleaned before placing new concrete.

(1) Bonding to Hardened Concrete

The surface of hardened concrete, upon which fresh concrete is placed, shall be rough, clean, and damp. Excess water shall be removed from the surface receiving concrete prior to placement. Hardened concrete shall be cleaned prior to placement of the fresh concrete to remove laitance and expose the aggregate.

An epoxy bonding adhesive shall be used. The epoxy bonding adhesive shall be installed in accordance with the manufacturer's instructions. Concrete shall be placed before the adhesive sets.

(2) Conveyance and Distribution

FTB and/or concrete shall be conveyed to the placement location by methods that prevent separation or loss of the ingredients.

(3) Depositing Concrete

FTB and/or concrete shall be placed so as to avoid segregation of materials and the displacement of reinforcing or embedments. FTB and/or concrete, dropped vertically, shall not be allowed to strike reinforcement or any other interference.

(4) Consolidation

Concrete shall be compacted using mechanical immersion type vibrating equipment. Mechanical vibrators shall maintain at least 9,000 cycles per minute when immersed in the concrete. Each vibrator shall be driven by a 1-1/2 hp (1 kW) or larger motor. The number and type of vibrators shall be acceptable to the Purchaser's Construction Manager.

(5) Hot Weather Concreting

Hot weather concreting shall be in accordance with the recommendations of the codes and standards specified.

At air temperatures of 90° F (32° C) and above, special procedures shall be used to keep the concrete as cool as possible during placement and curing.

(6) Cold Weather Concreting

Cold weather concreting shall comply with the codes and standards specified. When the average of the highest and lowest temperature during the period from midnight to midnight is expected to drop below 40° F (4° C) for more than 3 successive days, concrete temperature shall be maintained at 50° F (10° C) throughout the curing period.

Concrete shall not be placed on frozen ground. If the subgrade is frozen, it shall be removed before concrete is placed.

If freezing weather is expected, the subgrade receiving concrete shall be protected from freezing.

20.4.6 **Curing**

Concrete shall be protected from loss of moisture for not less than 7 days after the concrete is placed. Concrete with mineral admixtures shall be cured for 14 days.

Troweled surfaces, except those that receive a separate finish or coating, shall be cured with a membrane curing compound. Float finished surfaces, except those that receive a separate finish, may be cured with either a membrane curing compound or with water. Only water curing shall be used if the surface receives a separate finish unless the curing compound is compatible with the surface finish that will be installed.

(1) Water Curing

Water saturation of concrete surfaces shall begin as quickly as possible after initial set of the concrete, but not more than 30 minutes. The rate of water application shall be regulated to provide complete surface coverage with a minimum of runoff. The concrete surface shall not be permitted to dry.

Water retaining structures shall be water cured.

(2) Membrane Curing

Membrane curing compound shall be applied within 30 minutes after final finishing of the surface or as soon as possible after finishing without causing damage to the surface.

Membrane curing compound shall be spray applied at a coverage rate recommended by the compound manufacturer. A dissipating curing membrane may be used in lieu of wet curing on surfaces that will be covered at a later date with mortar, concrete, dampproofing, tile, or coating.

20.4.7 **Duct Banks**

Reinforcing steel and other magnetic materials installed in duct banks shall not enclose ducts unless they enclose all of the ducts in the duct bank.

Hardened surfaces that receive additional concrete shall have the surface prepared in accordance with this Specification. A bonding agent shall be applied prior to concrete placement.

Only Thermal Concrete shall be used for duct bank encasement and duct bank transitions.

Duct bank concrete shall be carefully poured and vibrated to avoid damaging the conduit. When the free- fall of concrete is greater than 6-feet, a cement sock (‘elephant trunk’) shall be used. Concrete shall be worked around reinforcements and embedments and into the corners of the forms.

20.4.8 **Field Control Testing**

When the testing specified in this Specification is to be conducted by the Purchaser, the Contractor shall furnish the necessary labor to assist the Purchaser's testing agency in obtaining, handling, and storing samples. When testing is specified to be conducted by the Subcontractor, tests shall be conducted in accordance with the following articles.

If material is sourced from multiple batch plants, separate sampling and testing will be required for each batch plant.

Test results shall be supplied to the Contractor within one week of test completion.

(1) Sampling

Field control tests shall be made at the point of placement in the presence of the Purchaser's Construction Manager. Equipment, supplies, and qualified personnel necessary for the field control testing shall be supplied. Sampling shall be in accordance with the standards listed in this Specification. Care shall be taken to ensure representative sampling, in order to accurately represent the material being placed.

Tests shall be performed by an acceptable independent testing laboratory or Subcontractor's qualified QA personnel in accordance with the codes and standards specified in this Specification. The frequency specified for each field control test is a minimum. Additional field control tests shall be made if requested by the Purchaser.

Flowable Thermal Backfill (FTB) is a Controlled Low Strength Materials (CLSM) and should be sampled and tested using methods and procedures specific to CLSM materials as specified by ACI and ASTM.

In particular CLSM materials require test cylinders be prepared from a sample container filled from the full flow of the discharge. Special curing and handling procedures are required to keep the samples intact due to their low compressive strength.

The testing frequency and requirements are indicated in Table 1 at the end of this section.

(2) Slump

A slump test shall be made from each batch of FTB or concrete used to make compression test cylinders.

When plasticizers and super-plasticizers are added at the site, the slump shall be measured and recorded before and after the addition.

(3) Air Content

An air content test shall be made from each batch of FTB, concrete and grout used to make compression test cylinders.

(4) Concrete Temperature

A temperature test shall be made from each batch of FTB, concrete or grout used to make compression test cylinders.

The following testing requires five cylinders. A strength test is an average of two cylinder breaks. This article provides a valid strength test for 28 days, plus a set for an additional test if needed. Since only one cylinder is tested at 7 days, this does not meet the requirements for a strength test; therefore, it only provides an indication of strength and not a strength record.

(5) Compression Tests

Compression test cylinders shall be made at the intervals indicated in Table 1 at the end of this section. A set of five test cylinders shall be made from the same batch at intervals listed in Table 1 at the end of this section. FTB cylinders shall be short-term cured on-site for minimum of 4- days. Concrete cylinders shall be short-term cured for minimum of 1-2 days. During cold weather operations (i.e., when temperatures fall below 50F), heated curing boxes shall be provided for short-term curing of cylinders to keep temperature between 60-80F.

Each set of compression test cylinders shall be marked or tagged with the date and time of day the cylinders were made, the location in the work where the FTB and concrete represented by the cylinders was placed, the delivery truck or batch number, the air content, and the slump.

For each set of cylinders, one cylinder shall be tested at an age of 7 days, two cylinders shall be tested at an age of 28 days, and two cylinders shall be stored until otherwise directed by the Purchaser's Construction Manager.

(6) Thermal Testing

Test cylinders for thermal testing shall be made at the intervals indicated in Table 1 at the end of this section. A set of two test cylinders shall be made from the same batch at intervals listed in Table 1 at the end of this section.

Each set of compression test cylinders shall be marked or tagged with the date and time of day the cylinders were made, the location in the work where the FTB or concrete represented by the cylinders was placed, the delivery truck or batch number, the air content, and the slump.

Test cylinder requirements for thermal testing shall be coordinated with the testing agency. Packaging methods and shipping frequency shall be coordinated with the testing agency. Samples shall not be held for more than one week before shipping to the testing agency.

Low strength materials such as FTB require special attention to packaging and shipping. Material shall have achieved minimum set prior to packaging (e.g., 4-days on-site curing). Test cylinders shall be capped and sealed prior to shipping. Test cylinders shall be packed and padded in shipped containers in such a manner as to prevent excessive movement and rattling against each other.

(7) Test Reports

Test reports shall contain the information specified by ASTM C39 and the following additional information:

Date, time, and ambient temperature of

pour Location of pour

Mix class

Table 1: Concrete Field Testing Requirements

Application	28 Day Compressive Strength	Compressive Test Frequency	Slump Req.	Slump Test Frequency	Air Content Req.	Air Content Frequency	Required Thermal Resistivity	Thermal Resistivity Test Frequency	Remarks
Thermal Concrete/ Duct bank Encaseme n t	4000 psi Minim um	Once per day, and once per 150 cu. yards	6" Max.	Once per day, and once per 150 cu. yards	2% Max	Once per day, and once per 150 cu. yards	50 °C-cm/Watt at 4% moisture, 100 °C-cm/Watt at 0% moisture	Once per day, and once per 150 cu. yards	Test frequencies are minimums, Purchasers Representative may request additional tests.
Flowabl e Therma l Backfill	300 psi Maximum	Once per day, and once per 250 cu. yards	Workabl e	Once per day, and once per 250 cu. yards	2% Max	Once per day, and once per 250 cu. yards	50 °C-cm/Watt at 4% moisture, 100 °C-cm/Watt at 0% moisture	Once per day, and once per 250 cu. yards	Test frequencies are minimums, Purchasers Representative may request additional tests.

20.5 WTG GSU Transformer and Grounding Transformers

20.5.1 **Transformer**

The Contractor shall install the WTG GSU transformer as described in drawings.

20.5.2 **Transformer Mounting**

The Contractor shall install the WTG GSU transformers as indicated on the drawings and install the high and low side cable connections. Transformers shall be properly anchored to prevent movement for short- circuits or seismic events. Transformers will be installed level in all directions. The Contractor shall furnish and install the 600 A dead break elbows as indicated on the One Line Diagram for the WTG transformer 35 kV terminations.

20.5.3 **Low Voltage (2000 V) Phase Conductors**

The Contractor shall furnish and install 2000V cable between WTG and GSU and transformer Ground Conductors.

20.5.4 **Low Voltage (2000 V) Conductors Terminations**

The Contractor shall furnish and install Burndy compression lugs for the WTG transformer’s low voltage phase and neutral conductors. The Contractor shall terminate the phase and neutral conductors at the GSU transformer and in the LVDP. Including all hardware to make the connections.

20.6 Switch Cabinet Installation

20.6.1 Switch Cabinets

The Contractor shall install equipment in accordance with the Drawings and Equipment Supplier's Installation Instructions.

20.6.2 Cable Splicing

Underground cable Splices are only allowed in those cases where cable lengths exceed maximum lengths provided on complete reels, unless listed in the cable management plan and approved by Owner.

- Where cables are to be spliced in an area of sufficient size must be excavated to provide environmental controls as needed.
- After cable is cut, a water-tight protective seal must be applied to exposed ends to prevent dirt and moisture from entering cable.
- A plastic tarp shall be placed under the cable and covering an area of at least 8-feet in diameter measured from the splicing location.
- A protective tent must be erected around the splicing location.
- The protective tent shall be large enough to completely cover the tarped area under and around the splice location.
- The protective tent shall have adequate seals to allow no dust or precipitation to blow into the splicing area.
- 3M QT III series for wind applications. Reference the drawings for applicable part numbers
- Raychem Heat Shrink MBSM-125/30-1200 or approved equivalent shall be used and install per manufacturers specifications.
- If the temperature at the splicing location is below 40-degrees F a heat source shall be located at the splicing location to heat the protective tent to 45-degrees F or more.
- The splice shall be installed per manufacturer instructions and training. All personnel installing splices shall complete manufacturer training for the specific splices to be installed.
- Certification documentation for each person installing splices shall be made available to the Owner.
- Personnel installing splices shall have completed training on installing the specific splices within 6-months of installing the splice.
- The Contractor is responsible for replacing terminations, cable or splices that do not pass quality control testing or meet IEEE or IEC Standards.
- Each installed splice shall be documented / recorded with personnel's name(s) that installed the splice.
- GPS coordinates shall be recorded and documented at each splice location. The location shall be marked on the as-built drawings with coordinates.

20.6.3 **Switch Cabinet Pads**

All switch cabinets shall be placed on a fiberglass foundation refer to detail drawings for requirements.

Cable entry shall be through conduits cast in the switch cabinet pad.

20.6.4 **Switch Cabinet Locations**

All switch cabinets locations are indicated on the detail drawings. They are located whenever possible near roads or WTG access areas to minimize damage by farm equipment. All switch cabinets shall have concrete barrier posts located around the boxes to minimize damage. Posts shall be set with concrete to provide additional impact resistance when struck by farm equipment. All final switch cabinet locations shall be reviewed by the Owner prior to construction.

20.7 35 kV Cable Termination Requirements

20.7.1 General

The contractor shall marker each cable end for identification during installation. Red tape shall identify phase A, White tape shall Indentify Phase B and Blue tape shall identify Phase C. Phase A shall start or terminate at the substation breaker that is identified as phase A. Phase B shall start or terminate at the substation breaker that is identified as phase B. Phase C shall start or terminate at the substation breaker that is identified as phase C. The cables entering a GSU shall be terminated on the following bushing in the GSU. The phase A cable shall terminate on the H1A bushing. The phase B cable shall terminate on the H2A bushing. The phase C cable shall terminate on the H3A bushing. On the switches, the A phase cable shall terminate on the top bushing, the B phase cable shall terminate on the center bushing, and the C phase cable shall terminate on the bottom bushing.

20.7.2 Substation Collector Feeder Terminations

The Contractor shall terminate the underground feeder circuits in the collector substation and shall coordinate the installation of the cables with the Collector Substation Contractor. Substation Contractor will provide conduits from 5 feet outside the substation fence to switchgear cabinet

Phase A shall start or terminate at the substation breaker that is identified as phase A. Phase B shall start or terminate at the substation breaker that is identified as phase B. Phase C shall start or terminate at the substation breaker that is identified as phase C.

20.7.3 35 kV 3-Way and 4-Way Switch Cabinets

The Contractor shall furnish and install 600 A dead break elbows to terminate the single conductor EPR 35 kV power cables with copper concentric neutrals at Contractor installed 4-way and 3-way switch cabinets. These elbow connectors shall be 600 A, dead break, 35 kV Class with a phase to ground rating of 22 kV. They shall meet the full requirements of ANSI/IEEE Standard 386. These elbow connectors shall be T-OPII connector system type connectors manufactured by Cooper Power Systems, or approved equal. On the switches, the A phase cable shall terminate on the top bushing, the B phase cable shall terminate on the center bushing, and the C phase cable shall terminate on the bottom bushing.

20.7.4 WTG GSU Transformer Terminations

The Contractor shall install 600 amp dead break elbows as indicated on the One Line Diagram for all WTG GSU transformer HV terminations. The cable shall be either; 1/0 AWG, 4/0 AWG, 350 kcmil, 750 kcmil or 1000 kcmil single conductor EPR three phase power cable with a copper concentric neutral. The elbow connectors shall be 600 A, 35 kV Class, three-phase rated (21.1/36.6 kV) load or dead break and shall meet the full requirements of ANSI/IEEE Standard 386. These elbow connectors shall be Cooper Power Systems or approved equal. Reference the Power Cable Schedule, for the various conductor sizes.

The cables entering a GSU shall be terminated on the following bushing in the GSU. The phase A cable shall terminate on the H1A bushing. The phase B cable shall terminate on the H2A bushing. The phase C cable shall terminate on the H3A bushing.

20.7.5 Substation Terminations

The Contractor shall furnish and install 35 kV stress cone terminations on 35 kV cable at the substation 35 kV termination structure. Terminations shall be Raychem Cat. No. HVT-35X-SJ or approved equivalent.

20.7.6 Surge Arresters

The Contractor shall furnish and install 22 kV metal oxide varistor arresters in pre-molded rubber elbows on each transformers. The arresters shall provide overvoltage system protection in an insulated, fully shielded, submersible, dead front device. The arrester housing interface shall conform to ANSI/IEEE Standard 386 and shall be as manufactured by Cooper Power Systems Cat. No. 3238120C27M, or approved equal, with a maximum discharge voltage of 110 kV at 20 kA. The Contractor shall install arresters at the last WTG GSU transformer in each WTG string.

Grounding requirements for these arresters appear in the drawings. Reference Collection System One Line Diagram Drawing for arrester locations.

20.7.7 **Fault Indicators**

The Contractor shall install directional Faulted Circuit Indicators (FCI), for all cables terminating at switch cabinets as indicated on the Collector System One-Line. Fault indicators will be Schweitzer test point reset with remote display.

20.8 Low Voltage Cable Installation

20.8.1 2000 V Power Cables

The Contractor shall furnish and install 2000 V rated cables between the low voltage (LV) GSU transformer and the WTG low voltage distribution panel, (LVDP). The cable shall be pulled in accordance with cable supplier's recommended pulling and installation practices.

The low voltage 2000 V cables shall be single conductor, rated at least 2000 V, 90-degrees C, suitable for wet and dry locations in conduit or underground duct systems. Insulation shall meet or exceed all requirements of applicable ICEA, NEMA, and UL Standards. Cable shall be factory tested to insure its compliance with the requirements of the referenced codes and standards.

Conduits shall be sealed at the Transformer and the WTG tower end.

Cables will be triplexed in the conduits and they shall be color coded Brown, Orange, Yellow to identify phasing.

20.8.2 Low Voltage Neutral Conductors

The Contractor shall furnish and install neutral conductors between the WTG GSU transformer's LV neutral terminal and the WTG's "T – Bar" connected to foundation bolts.

20.8.3 Low Voltage (2000 V) Conductors Terminations

The Contractor shall furnish and install Burndy compression lugs for the WTG transformer's low voltage phase and neutral conductors. The Contractor shall terminate the phase and neutral conductors at the GSU transformer and in the LVDP.

20.9 Meteorological (MET) Tower 200AMP 120/240V & Fiber Optic Cable Installation

20.9.1 Met Tower 200Amp 120V/240V Power Cable

The local Coop shall size, furnish and install direct buried cable, transformer and meter pedestal to the edge of Road Right of Way near the MET Tower. The meter pedestal will provide 120/240 V single- phase power for the MET tower equipment. The contractor shall install service wire from the meter pedestal to the service panel and connections to the Met tower. The cable shall be 600 V, 90-degrees C dry location/75-degrees C wet location, suitable for installation in conduit, underground duct systems, and/or direct buried. The insulation shall meet or exceed all requirements of applicable ICEA, NEMA, and UL Standards. Cable shall be tested in the factory to determine its compliance with the requirements of the referenced codes and standards. The Contractor is responsible for providing the power cable from the pedestal located outside to the MET Tower to the service panel inside the MET Tower.

20.9.2 MET Tower Communications

The Contractor shall install the MET tower fiber optic cable as per the drawings and furnish and install an outdoor wall mount panel manufactured by Clearfield (Part Number WDZ-024-A1F-ZZZ).

20.9.3 MET Tower Grounding

Contractor to furnish and install MET tower ground grid as shown on drawings. Including connections to the tower legs and fence.

20.10 Fiber Optic Communication Cable Installation

20.10.1 General

The Contractor shall install a fiber optic network that shall connect individual WTG's with the Operations & Maintenance (O&M) Building and the Substation Control House. The Contractor shall also install fiber optic cable between the substation control house and the terminating dead end of the transmission line.

The fiber cable shall be placed in 2 inch innerduct. All splicing shall be made at the WTG's, Operations & Maintenance Building Substation Control House and the splicing hand holes as indicated in the drawings. Sufficient spare length shall be provided for maintenance provisions. No running splices shall be made. When cables approach the end of a spool, the cable shall be routed to the nearest appropriate WTG or splice location.

Contractor will supply and install 24x36x24 polymer concrete hand holes with 20k lid or equivalent at the handhole locations as shown in the drawings. The bottom of the handholes shall be lined with crushed rock 1/2 inch diameter. The cable shall be coiled around the perimeter with splices hung on wall brackets provided with the handhole.

Contractor shall furnish, install and ground the Fiber Optic Splice Cabinet, Emerson Part # PADMT200300, and OPFOBD7, at each WTG location. The cable shall be terminated within the splice cabinet using Tyco FOSC 450-BS series splice cases inside of the cabinet. The cable shall be terminated within the splice cabinet. The Contractor shall furnish, install and terminate a Clearfield patch panel, Model # GXJ-024-A1B-AA8-01 037M inside the WTG. All connectors on the patch panel shall be labeled 1/2, 3/4, to 23/24 from left to right. Installation of the patch panel in the WTG will have to be coordinated with turbine OEM to be done after erection of the WTG. The fingers on the front of the panel will have to be removed to fit in the enclosure.

20.10.2 **Cable Specification**

The Contractor shall furnish and install all fiber optic cable required. The cable shall be Part # D-024-LN- 8W-F12NS manufactured by COMMSCOPE (or purchaser approved equivalent). The approximate quantities of fiber optic cable to be furnished can be obtained from the Collector System Fiber Optic Cable Schedule. Contractor is required to confirm fiber cable lengths in the field before ordering the cable. The fiber optic cable shall meet or exceed the physical characteristics mentioned below:

Fiber Optic Type	**Single Mode**
Fiber quantity	24
Fiber diameter	9/125 Microns
Maximum attenuation	0.4 @ 1310nm dB/km, 0.2 @ 1550nm dB/km
Operating temperature range	-40- to +70-deg. C

20.10.3 **Fiber Cable Installation**

The fiber cable shall be installed in the direct buried duct by blowing or pulling. The fiber cable may be installed in the same trench as the power cable. The fiber optic cable shall be configured in the trenches as shown in the Drawings. The Contractor shall furnish and install underground warning tape over fiber cable if not routed in the same trench as the power cables. In addition, the contractor shall furnish and install a tracer wire (gray, 12 AWG, THHN) with the duct with the fiber optic cable and terminated to ground in the splice cabinets and/or hand holes. The tracer wire shall not enter into the substation or into the WTGs.

The Contractor shall install fiber optic cable in a 2-inch HDPE innerduct when fiber cable is to be installed in substation trendway.

The Contractor shall test continuity of the fiber optic cable on the spools prior to laying. The Contractor and Owner shall witness these tests and determine if the spooled cable is ready for installation. The Contractor shall follow fiber cable manufacturer and industry standards for laying fiber cable.

The Contractor shall install fiber optic cable in a 2-inch HDPE innerduct, between the cable trench and the conduit stub-out at the WTG locations as shown in the drawings. The conduits shall be sealed after the fiber optic cables are installed to prevent rodent entry into the tower. The Contractor shall terminate all fibers into the fiber optic splice enclosures as detailed in the fiber optic connection documentation provided. All 2-inch HDPE innerduct shall be furnished by the contractor and shall be sealed at every penetration.

All fiber optic cable sheath lengths shall be recorded at each facility and handhole entry and exit. The sheath footage recordings shall be considered as part of the as-built drawings upon the completion of the cable installation.

Contractor shall place minimum 8 foot by 5/8 inch ground rod at each hand-hole splice location and bond a 6 AWG copper cable to the ground rod and terminate on the hand-hole terminal block. In addition, the Contractor shall provide, place and terminate additional 6 AWG grounding harnesses to the splice enclosures as shown in the drawings.

The Contractor shall verify and test the complete fiber optic network after all connections are made.

20.10.4 **WTG Fiber Optic Cable Entry**

The WTG conduit shall be sealed after the fiber optic cables are installed to prevent rodent entry into the tower.

20.10.5 **Cable Manufacturer Requirements**

The cable manufacturer shall be responsible for all phases of manufacturing, packaging and the safe keeping of the fiber-optic cable while at his facility. Prior to shipping, the cable manufacturer shall test each optical fiber to verify conformance to the specification herein and the optical glass fiber manufacturer's specifications. Each of the optical fibers in each of the cable reels shall be completely tested with an Optical Time Domain Reflectometer (OTDR) at optical wavelengths specified on an end-to-end basis. A printed hard copy of the final test data completed prior to shipment shall be attached in a waterproof envelope or pouch to each reel of cable provided.

20.10.6 **Fiber Optic Communications Drawings and Data**

All drawings and technical data required to be furnished by the Contractor shall be in English and all dimensions on the drawings shall be in feet and inches and all weight in pounds. The drawings shall be complete and accurate in their content. Originals and all copies shall be legible.

The Owner shall have the right to require the Contractor to make any changes in the drawings and data that may be necessary to show the placement of the fiber optic cable and all hardware conforms to the requirements of these specifications.

The following table summarizes the drawings and data required under these specifications:

DRAWINGS AND DATA SCHEDULE FOR FIBER OPTIC CABLE		
Type of Drawings and Data	**Delivery Time**	**Type of Material**
Factory Test Results of CABLE	With Shipment	Test Results
Pre-Installation Field Test Results of CABLE	14 Days After Receipt of Cable	OTDR Charts and Disk
Post-Installation Field Test Results of CABLE	14 Days After Completion Of Tests	OTDR Charts and Disk
Certification of Splicing Personnel	14 Days Prior to Fiber Splicing	Copy of Certification

20.11 Collector Ground Systems

20.11.1 General Description

The collector grounding system consists of the following: WTG grounding, GSU transformer grounding, grid for grounding transformer, underground splice grounding, switch cabinet grounding and MET Tower grounding. The copper concentric neutral on each conductor will interconnect these ground systems together and back to the Power Delivery Station. The MET Tower grounding system **shall not** be interconnected to the collector grounding system.

Contractor shall provide and install all WTG, GSU Transformer, Grounding Transformer, MET Tower, and 35 kV Switch Cabinet Grounding systems as shown on the drawings

(1) General

The grounding system for the 35 kV switch cabinet is designed to achieve a minimum

10.0 Ohms resistance. Fall of potential measurements shall be made after installation. If ground resistance is found to exceed 10.0 Ohms resistance, then radial ground leads can be extended from the ground loop and additional ground rods installed. (Owner shall approve any expansion to the ground system).

(2) Switch Cabinet

The grounding system consists of a ground loop and ground rods. The ground loop shall consist of stranded copper ground conductor installed in a 4-inch wide, 3-foot deep trench around each 35 kV switch cabinet. The trench shall be in undisturbed soil approximately 4-feet from the switch cabinet base approximately 4-inches of well compacted select native fill, with no rocks larger than what would pass through a number 4 screen, shall surround the ground conductor.

Four 5/8-inch diameter, 8-foot long copper clad ground rods shall be driven at each corner and connected to the loop. Stranded copper pigtail from the ground loop shall be brought into the switch cabinet and connected to the ground bus as shown on the drawings

(3) 35 kV Power Cables at Switch Cabinet

For the 35 kV power cables terminating in 4-way or 3-way switch cabinet, each cables concentric neutral shall be terminated with a compression type, 2-hole lug and connected to a common ground bus.

20.11.2 **Trench Grounding**

The 35 kV power cables concentric neutrals shall be grounded every 1,250 feet of cable length using a Raychem JGK-MS-2 and JGK –MS-3 sized for the cable run. Refer to drawings for details.

20.11.3 **WTG GSU Transformers and Grounding Transformers**

For the 35 kV power cables terminating at the WTG GSU transformers, each cables concentric neutral shall be brought up into the high voltage terminal compartment through the 35 kV cable conduits, terminated with a compression type 2-hole lug, and connected to the transformer tank ground pad.

WTG GSU transformer’s LV neutral terminal and the WTG’s LVDP ground.

20.11.4 **MET Tower Grounding**

MET Tower grounding to be installed by WTG Grounding Contractor. MET Tower grounding shall not be interconnected to the wind project grounding system, only power and fiber cable shall connect the MET Tower to the nearest WTG.

20.12 Testing

The Contractor shall complete and submit to Owner the test forms supplied for each test. A detailed testing procedure with forms will be supplied by the Owner. The testing will include the following items.

20.12.1 **Grounding Test**

The Contractor shall use the Three Point Fall of Potential Method per IEEE STD 81 for measuring and testing the ground resistance of the switch cabinets.

(1) Switch Cabinet

The grounding point inside the cabinet should be selected as the system connection point (E). The minimum distance from E to the current electrode (CE) is 600-feet. Resistance measurements shall be taken with the potential electrode (PE) at 200-feet, 250-feet, 300- feet, 350-feet, 400-feet, and 450-feet from E. When performing the test, the line of test should pass through the center of the grounding system being measured, and the potential and current electrode should be tested in an approximate straight line.

(2) WTG Grounding Grid

The grounding point inside the cabinet should be selected as the system connection point (E). The minimum distance from E to the current electrode (CE) is 600-feet. Resistance measurements shall be taken with the potential electrode (PE) at 200-feet, 250-feet, 300- feet, 350-feet, 400-feet, and 450-feet from E. When performing the test, the line of test should pass through the center of the grounding system being measured, and the potential and current electrode should be tested in an approximate straight line.

20.12.2 **12.2 Underground Power Cable Test**

The Contractor shall perform the following tests to confirm acceptability of the installed cable installation. Contractor is responsible for all costs related to confirming the test results, identifying defects, correcting defects and retesting any cable system which is not acceptable. Contractor shall provide test reports for each test performed. Reports shall include date, time, location, ambient temperature, weather conditions, cable description, cable and circuit identification, test operator, test equipment, and Pass/Fail in addition to all relevant test data.

Owner shall approve the Contractor's testing plan prior to testing.

(1) 12.2.1 Cable Rated 5kV Through 46KV

Contractor shall test the complete cable system after all splicing and termination has been completed. Tests shall be run from termination to termination. Testing shall be in accordance with IEEE-400 IEEE Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable System. Equipment used for testing shall meet all requirements in IEEE 400 and the appropriate "point" article for the specific test.

Contractor shall perform VLF AC voltage stress test on all cables. Cable will be tested at 62 kV peak (44 kV RMS) voltage to ground and at a frequency of 0.1 Hz. Test duration will be 30 minutes after reaching 62 kV.

20.12.3 **Fiber Optic Cable**

Prior to installing the fiber, verify the cable on the reel is undamaged visually and test the fiber optic cable with a high-resolution OTDR. The Contractor shall supply a certified optical trace from the OTDR using dual wave lengths.

After fiber optic cable is installed and spliced, verify the cable and connector integrity with a fiber optic high-resolution OTDR.

(A) Factory tests shall be performed on each fiber of every reel at the factory. Results shall be recorded and included in the packaging with the cables. Product data sheets showing the cable characteristics including dispersion, dimensional quality, and tensile strength shall be provided from the manufacturer.

(B) The installation Contractor shall test all fibers of each reel prior to taking delivery from the Owner. Notify the Owner at least 7 days prior to all pre-installation field tests to enable the Owner's Representative to be present. Contractor shall submit optical time domain reflectometer (OTDR) charts at both 1310 nm and 1550 nm showing launch conditions and all other parameters used in the setup, time and date shall be included. A 1 km launch fiber shall be used. These charts shall illustrate and quantify the losses of each length of fiber and stress points in the fiber. Review the traces carefully and explain unusual discontinuities in detail. Photographs of OTDR test results will not be accepted. The OTDR testing and waveforms shall be stored on recordable media and included with the submittal. All pre-installation tests on the fiber optic cable shall be compared to the factory test results. If the overall attenuation for a fiber increases by more than 1 dB, the reel will be rejected.

(C) Contractor shall notify the Owner at least 7 days prior to the post installation field tests to enable the Owner's Representative to be present. Contractor will perform end to end tests for each fiber after all splices have been completed and all splice enclosures, except for those required for fiber access during testing, have been returned to their permanent position. The test shall include, optical time domain reflectometer (OTDR) charts at both 1310 nm and 1550 nm showing launch conditions and all other parameters used in the setup, time and date shall be included. OTDR measurements shall be made in both directions, if possible and the splice loss results bi-directionally averaged. These charts shall illustrate and quantify the losses of each length of fiber and stress points in the fiber. Bi-directional averaged values shall be clearly displayed on a separate chart that identifies each splice location by tower number and direction of measurement. Review the traces carefully and explain unusual discontinuities in detail. Photographs of OTDR test results will not be accepted. The OTDR testing and waveforms shall be stored on recordable media and included with the submittal. If the OTDR testing is performed using equipment that produces a .TRC file. All post-installation tests on the fiber optic cable shall be compared to the pre-installation test results. Bi-directionally averaged splice loss shall not exceed 0.2 dB.

(D) Power Meter Testing – After completing all required splicing and termination work, Contractor shall perform a final power meter test to measure the actual optical attenuation of each optical circuit. Power metering shall be unidirectional (one direction per fiber) at 1310 and 1550 nanometers of wavelength. The Contractor shall perform optical power meter testing by injecting a light signal of known signal level into the patch panel connector (transmit side) then record the received level at the patch panel connector (receive side) and record the total signal attenuation in decibels (dB) across the optical circuit. Contractor shall record the results and provide such results to the Owner. The total system loss for the fibers shall be no more than 5 dB at 1310 and 1550 nm.

(E) All test equipment shall be calibrated with certification traceable to the National Institute of Standards and Technology relative to their intended use.

(F) The fiber optic tester shall have a minimum of one year testing and operations experience with the OTDR and optical loss test equipment used for tests required in this specification and shall be able to use all necessary test equipment without reference to test equipment instruction books while performing the required tests specified herein. All personnel performing splicing shall be certified to do so by the Electronic Technician Training Association or equivalent training program.

20.13 Cable Numbering & Equipment Labeling

The Contractor shall provide material and labor for installation of cable numbers and equipment labels.

20.13.1 35 kV Power & Fiber Optic Cable Numbering

The Contractor shall label the power and fiber optic cables at each termination point with identification numbers that are listed in the Power and Fiber Optic Cable Schedules. The power cables shall also have the phase identifier in the label. The labels should be thermal printed type with adhesive material for wrapping them around the entire cable outer jacket.

20.13.2 35 kV Power Cables

(1) General

The 35 kV power cables shall be numbered at each of the following termination points: Substation, Grounding Transformers, WTG GSU Transformers, and 35 kV 4-way and 3-way switch cabinets. Each power cable will also be identified for phasing with the following colored tape during installation: Red for A phase, White for B phase and Blue for C phase. The phasing will be the same throughout the project. The Contractor shall obtain and record the proper phasing in Owner's substation at the beginning of the project for phase identification on each power cable.

(2) WTG Transformers and Grounding Transformers

Each 35 kV cable inside the high voltage compartment of the WTG GSU transformers shall have a cable number label installed. These labels shall consist of Brady 1-3/4-inch by 12-inch aluminum utility panels with 1-1/2-inch by 1-inch adhesive Bradylite reflective numbers and letters installed on the panels to correspond to the circuit number in the Power Cable Schedule. These aluminum utility panels shall be secured to the cables with nylon cable ties with 0.2% carbon filled, locking, black, and weather resistant such as "Pan-Ty" or "Ty-Rap". Phase identification for the WTG GSU transformers shall be per the Owner's specification and is as follows: H1 Phase A (red tape), H2 Phase B (white tape), and H3 Phase C (blue tape).

(3) 35 kV 4-Way and 3-Way Switch Cabinets

Each individual 35 kV cable inside the termination compartment shall have a cable number label installed. These labels shall consist of an Almetek 1-3/4-inch by 12-inch polyethylene E-Z Tag with 1-9/16-inch by 7/8-inch reflective numbers & letters to correspond to the circuit number in the Power Cable Schedule. Both ends of these E-Z Tag holders shall be secured to each power cable with nylon cable ties with 0.2 percent carbon filled, locking, black, and weather resistant such as “Pan-Ty” or “Ty-Rap”. Cable ties shall not be tightened excessively to cause deformation of the tag holder. The labels shall be visible when the termination compartment doors are opened. Phase identification for each way in the switch cabinet is as follows: Red for Phase A, White for Phase B and Blue for Phase C.

(4) Fiber Optic Cable Labeling

Each fiber optic cable pulled into the hand holes and spliced, terminated at the WTGs and terminated at the Operations and Maintenance and Substation buildings shall have a Contractor provided cable number label that corresponds to the cable number in the Fiber Optic Cable Schedule. The labels should be thermal printed type with adhesive material for wrapping them around the entire cable outer jacket.

20.13.3 Switch and Equipment Labeling

(1) General

The Contractor shall provide identification nameplates made of laminated three-ply plastic, equal to Lemuroid. Nameplates shall be a minimum of 1/16-inch thick with yellow outer layers on a black core. Edges shall be chamfered. Nameplates shall be mounted to the equipment by using stainless steel screws. These screws can be either the self drilling or drilled and tapped type. Pop rivets are not acceptable.

(2) 35 kV 4-Way and 3-Way Switch Cabinets

Each of the 4-way and 3-way switch cabinets shall be labeled with a High Intensity Scotchlite Almetek utility quality reflective numbering system with 6-inch high letter size identifying the junction or splice box number. These labels and a 5-inch by 3.5-inch “Danger High Voltage” sign, Brady Cat. No. 86238 or approved equivalent shall be installed on the side of the enclosure that will be opened for access to the terminals inside.

Switch cabinets shall be identified as shown on the Collector system one-lines, example: 801ALPHA. Labeling is to be located on the access cover of the switch cabinet and on the side facing the road access.

Switch cabinet’s switch handles shall be identified as shown on the Collector System One-Lines, example: 801 ALPHA 44.

(3) WTG GSU Transformers and Grounding Transformers

Each of the WTG GSU transformers shall have an engraved phenolic label with 3/4-inch letter size and High Intensity Scotchlite Almetek utility quality reflective numbering system with 6-inch high letters identifying the transformer. These labels shall be installed on the HV compartment door. Reference the Collection System One-Line Diagram for engraving information.

GSU transformer internal labeling shall be as identified as shown on the Collection System One-Lines, example: 23H1. The label 23H1 shall include the elbows H1, H2, and H3. The 23H1 label shall be centered above the H2 elbow.

20.14 Construction Drawing List

The drawings forming part of this specification are listed in the most current version of the Master Drawing and Specification list.

21.0 EXHIBIT 8 – MP SUBSTATION SPECIFICATIONS

MINNESOTA POWER

STANDARD EQUIPMENT SPECIFICATION

OUTDOOR GANG OPERATED

AIR BREAK SWITCHES

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Signature:___________________________________

Typed or Printed Name: Ryan Bishop
Date: October 15, 2021 License No.: 51308

Date	Prep	App
10/15/21	PJK/BV	RJB

Standard Number

AB02PA

(Rev 5)

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1. SCOPE

This standard covers outdoor, high-voltage, air break switches used on Purchaser's transmission system. Manufacturer shall quote in strict conformance with these specifications. All exceptions to these specifications or any required standard shall be stated and explained in the submitted quotation.

2. REFERENCE STANDARDS

Switches shall be designed, manufactured, tested, and furnished according to the latest edition, revisions or amendments to the applicable standards of ANSI, NEMA and IEEE including:

2.1 IEEE Std. C37.30.1-2011.

2.2 The equipment shall be manufactured to be in compliance with all applicable standards adopted pursuant to the Williams-Steiger Occupational Safety and Health Act of 1970. Any perceived conflicts between this specification and the outlined standards shall be brought to the attention of Purchaser to determine course of action.

3. TECHNICAL REQUIREMENTS

3.1 GENERAL

3.1.1 The switches shall be designed for the System Characteristics and Service Conditions outlined in ***Supplement Specification AB02PA-S1***.

3.1.2 Switches shall be of all new materials and of the latest manufacture and design. Rebuilt or used switches will not be acceptable.

3.1.3 Motor operators, if required, will be supplied by others.

3.1.4 Manufacturer shall provide all provisions necessary to mount the switch and operating mechanism components to Purchaser supplied structural steel. Refer to the ***Bid Documents*** for steel mounting details.

3.2 ELECTRICAL REQUIREMENTS

3.2.1 The switch electrical ratings shall be per ***Supplement Specification AB02PA-S1***.

3.2.2 Switches shall be furnished with standard NEMA size terminal pads, compatible with aluminum or copper terminal connectors. Terminal pads shall be appropriately sized to carry the entire ampacity of the switch.

3.2.3 Switch live parts shall be aluminum.

3.2.4 The switch shall have arcing horns/accessories to protect the current-carrying contacts.

3.2.5 Unless otherwise indicated in the Bid Documents, insulators shall be supplied and switches shall ship with the insulators installed.

3.2.6 Insulators shall be porcelain or composite per ***Supplement Specification AB02PA-S1*** and comply with Minnesota Power Standard Specification BS03PA – Station Post Insulators.

3.3 PHYSICAL/MECHANICAL REQUIREMENTS

3.3.1 The switch shall be designed per the Physical Characteristics outlined in ***Supplement Specification AB02PA-S1***.

3.3.2 All switch components shall be sky gray in color and conform to standard color designation ANSI #70.

3.3.3 Each switch blade shall form one solid piece and shall be so assembled that no parts of the blade can move relative to one another.

3.3.4 All jaw contacts shall be stationary and designed so that wiping action is provided with a minimum of roughening or wear on the surfaces.

3.3.5 Bearings for the rotating insulator stacks shall be tapered roller or double ball type. If of the latter type, the bearings shall be of the combination radial and thrust type. All ball or roller bearings shall be of the sealed, permanently lubricated type.

3.3.6 Interphase linkage shall be of the torsional type or an acceptable substitute. All interphase connections and mounting hardware shall be supplied for single gang throw operation. All interphase connecting pipe fittings shall have piercing screws. All interphase connecting pipe shall have means of preventing water retention inside pipe by way of weep holes, open ends or combination thereof.

3.3.7 Leveling nuts shall be incorporated for plumbing all insulator stacks.

3.3.8 The switch linkage shall over-toggle into the fully open or fully closed positions and shall have adjustable mechanical stops for both the open and closed positions.

3.3.9 Operating mechanisms shall effect a smooth, thoroughly controlled movement throughout the entire opening and closing cycle and all rods, shafts, pipe linkages, connectors, operating levels, supports, and fittings shall show no noticeable deflection. Cable connections in lieu of rigid interphase rods are not acceptable.

3.3.10 A means shall be provided on each switch for taking up loose motion in each part of the mechanism and for adjusting the travel of each blade independently. The design of the mechanism shall be such that the main blades are positively toggled when in the fully open or fully closed position.

3.3.11 The manual operator shall be easily turned by a person of average strength without need for extension pipes or levers (35 lbs. for a worm gear operator and 60 lbs. for a swing handle operator).

3.3.12 The switch operator rod shall be supplied with an open/close indicator to identify current position of switch.

3.3.13 A swing handle or gear operator accessible for operation at ground level shall be provided.

3.3.14 There shall be provisions for padlocking the operator in both the open and closed positions.

3.3.15 An appropriately sized, flexible ground jumper shall be provided for the operating handle.

3.3.16 The switch shall have quick break whip/accessories to protect the current-carrying contacts **See *Supplement Specification AB02PA-S1* if applicable**.

4. TESTS

4.1 Manufacturer shall provide design test reports for all applicable design tests described in NEMA and IEEE standards including IEEE Std. C37.30.1-2011

4.2 Switches shall be subjected to all applicable production tests described in NEMA and IEEE standards including IEEE Std. C37.30.1-2011. Manufacturer shall provide a list of factory tests performed to verify proper mechanical or electrical operation of the switches.

4.3 Purchaser reserves that right to witness factory testing. Manufacturer shall notify Purchaser a minimum of two (2) weeks prior to the start of testing.

4.4 One (1) digital copy of certified test reports shall be supplied for each switch.

5. DOCUMENTATION

5.1 Information Required with Proposal

Manufacturer shall provide the following for each unique type of disconnect switch:

5.1.1 Data as indicated in Section 13.

5.1.2 Outline drawings showing overall dimensions and relative location of all principal components

5.1.3 General description of type of materials used for principal components

5.2 Documents Required for Approval

Manufacturer shall provide one (1) electronic copy (AutoCAD or Adobe Acrobat Format) of the following for each unique type of switch:

5.2.1 Outline drawings.

5.2.2 Base detail.

5.2.3 Nameplate Drawing

5.2.4 Instruction Manual

5.3 Documentation Required for Record

Approval drawings will not be retained for record purposes. Manufacturer shall provide one (1) electronic copy (AutoCAD 2007 or Adobe Acrobat Format) of the following for each switch to be used for Purchaser's final records:

5.3.1 Outline drawings.

5.3.2 Base detail.

5.3.3 Nameplate Drawing with serial number

5.3.4 Instruction Manual

5.3.5 Installation Instructions

5.3.6 Certified Test Reports

One set of instruction books and drawings shall be shipped with the Switches in a weatherproof envelope.

6. TOOLS

Manufacturer shall provide a list of any special tools required for installation, operation, or maintenance with pricing to be included as an adder on the proposal.

7. SPARE PARTS

Manufacturer shall provide a list of recommended spare parts with pricing to be included as an adder on the proposal.

8. SERVICE

The service of a competent installation technician may be required: to inspect the complete installation, to be responsible for the proper installation and operation of the switches, and to perform all tests that may be necessary. All quotations must include the cost of a competent installation technician as an adder on the proposal.

9. WARRANTY

Manufacturer warrants the equipment furnished is free from defects in material and workmanship and agrees to repair or replace any unit unsuitable for operation or which fails during normal and proper operation. The warranty shall be for a minimum of twelve (12) months from date of initial operation or eighteen (18) months from date of acceptance, whichever comes first.

10. PACKAGING AND DELIVERY

10.1 Manufacturer shall quote FOB site delivery. ***See Bid Documents*** for delivery location.

10.2 All switch components shall be securely strapped to a hardwood pallet(s) rated to support its weight.

10.3 All switch components shall be protected from dirt, road grime, and flying debris during transit. Protection shall be shrink wrap, bubble wrap or other protective covering.

10.4 Switches shall be shipped by open flatbed truck only. There is no freight dock at delivery location.

10.5 Purchaser shall be notified a minimum of three working days before delivery.

10.6 Regular delivery hours are 8:00AM until 3:00PM, Monday thru Friday. Deliveries outside regular hours shall be coordinated with Purchaser and are subject to Purchaser approval.

10.7 Contact for Delivery: ***See Bid Documents***

11. ADDITIONAL INFORMATION

11.1 This standard shall be accompanied by the ***Supplement Specification AB02PA-S1***: Ratings and Technical Requirements completed by Purchaser, and **Section 13:** Specific Information Required with Quotation for Manufacturer to complete.

11.1 Purchaser Proposed Schedule: ***See Supplement Specification AB02PA-S1 and Bid Documents***

11.2 Contact for Technical Questions: ***See Bid Documents***

12. RATINGS AND TECHNICAL REQUIREMENTS

12.1 Purchaser Proposed Technical Requirements: ***See Supplement Specification AB02PA-S1***

12.2 Table 1 Technical Information: ***See Next Page***

Table 1			
Nominal System Phase-to-Phase Voltage (kV)	**Maximum Voltage (kV)**	**Power Frequency Withstand Voltage Wet (kV)**	**Lightning Impulse Withstand Voltage (kV)**
13.8	15.5	45	110
23	25.8	60	150
34.5	38	80	200
46	48.3	95	250
69	72.5	140	350
115	121	230	550
138	145	275	650
161	169	315	750
230	242	385	900

13. SPECIFIC INFORMATION REQUIRED WITH QUOTATION

Manufacturer shall submit the following completed form with their bid. **One form shall be used for each unique item quoted.** Failure to complete the form will result in a $1000 addition to the evaluated price.

13.1 General Information

a. Line Item/Description/Label		
b. Manufacturer		
c. Point of Manufacturer		
d. Domestic Content		%
e. Delivery Date		Weeks ARO
f. Price per Unit (Tax NOT included)	$	
g. Warranty		Months Post Delivery
		Months Post Install
h. Type/Model Number		

13.2 Documentation Transmittal Time

a. Preliminary Drawings		Weeks ARO
b. Final Outline		Weeks ARO
c. Name Plate		Weeks ARO

13.3 Service Conditions

a. Ambient Temperature Rating		
b. Maximum Altitude		ft
c. Maximum Wind Speed		miles/hr
d. Maximum Ice Loading		inches
e. Maximum Seismic Performance		

13.4 Electrical Characteristics

a.	Rated Maximum Voltage		kV
b.	Power Frequency Withstand Voltage		kV
c.	Lightning Impulse Withstand Voltage		kV
d.	Continuous Current Rating		A
e.	Peak Withstand Current Rating		kA
f.	Short-Time Withstand Current Rating		kA
g.	Short-Time Withstand Duration		Sec
h.	Line Charging Current Rating (Phase Spacing per Supplement AB02PA-S1 and/or Bid Documents)		A
i.	Magnetizing Current Rating (Phase Spacing per Supplement AB02PA-S1 and/or Bid Documents)		A

13.5 Physical Characteristics

a.	Blade Opening (Vertical, Double End, etc.)		
b.	Mounting (Horizontal, Vertical, Inverted)		
c.	Style		
d.	Operator (Manual, Motor Operator)		
e.	Insulator T.R No		
f.	Insulator Material (Porcelain or Composite)		
g.	Direction of Operation (to open)		
h.	Degrees of Operation		
i.	Interrupter Accessories (Arcing Horns, Quick Break Whips, etc.)		
j.	Height (bottom of base to top of terminal)		in

k.	Height (bottom of base to top of open blade)		in
l.	Width		in
m.	Depth		in
n.	Shipping Height		in
o.	Unit Weight (Approximate)		Lbs.

13.6 Applicable Factory Testing

13.7 Added for special tooling per Section 6

Tool or Device	Price
	$
	$
	$

13.8 Adder for recommended spare parts per Section 7.

Spare Part	Price
	$
	$
	$

13.9 Adder for services per Section 8.

Service	Price
	$
	$
	$

13.10 Exemption(s)

13.11 Required Documents Checklist

Manufacturer shall provide the following with quotation:

(i) Design Test Results	
(ii) Instruction Manual	
(iii) Outline Drawing	
(iv) Nameplate Ratings	

14. REVISION TABLE

Number	Date	By	Reviewed	Description
0	01/02/18	ARS		Original
5	08/19/21	PJK/BV		Created AB02PA-S1 Supplemental Spec and Changed section numbering, rearranged sections 12, 13 & 14, revised 3.2.6 for insulator type.
2	09/27/18	ARS		
3	11/04/19	DJS/KJB	DJS	Added PE Stamp to Title Page, revisions pages 1,3,,4 and updated Table 2 on page 7
4	12/11/19	LAG/KJB	DJS	Revision to page 2 Section 3.3.6
5	10/15/21	PJK/BV	RJB	Created AB02PA-S1 Supplemental Spec and Changed section numbering, rearranged sections 12, 13 & 14. Revision to 3.1.4, 3.2.6, 5.3.3 and 13.5. Updated Table 1 & removed Table 2

MINNESOTA POWER

STANDARD EQUIPMENT SPECIFICATION

OUTDOOR THREE POLE

SF6 GAS CIRCUIT BREAKERS

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Signature:___________________________________

Typed or Printed Name: Ryan Bishop
Date: October 15, 2021 License No.: 51308

Date	Prep	App
10/15/21	PJK/BV	RJB

Standard Number

CB01PA

(Rev 4)

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1. SCOPE

This standard covers outdoor, high-voltage, SF_6 gas circuit breakers (breakers) used on Purchaser's transmission and distribution system. The manufacturer shall quote in strict conformance with these specifications. All exceptions to these specifications or any required standard shall be stated and explained in the submitted quotation.

2. REFERENCE STANDARDS

The circuit breaker shall be designed, manufactured, tested, and furnished according to the latest edition, revisions or amendments to the applicable standards of ANSI, NEMA and IEEE including:

2.1 IEEE Std. C37.04

2.2 IEEE Std. C37.09

2.3 IEEE Std. C37.11

2.4 NEMA Power Circuit Breaker Standard Publication No. SG 4, latest revisions

2.5 The equipment shall be manufactured to be in compliance with all applicable standards adopted pursuant to the Williams-Steiger Occupational Safety and Health Act of 1970. Any perceived conflicts between this specification and the outlined standards shall be brought to the attention of Purchaser to determine course of action.

3. TECHNICAL REQUIREMENTS

3.1 GENERAL

3.1.1 The circuit breaker shall be designed for the System Characteristics and Service Conditions outlined in ***Supplement Specification CB01PA-S1***.

3.1.2 The breaker shall be furnished complete and ready for operation with operating mechanism, structural steel support, and all accessories necessary for operation.

3.1.3 The breaker shall be of all new materials and of the latest manufacture and design. A rebuilt or used circuit breaker will not be acceptable.

3.2 OPERATING MECHANISM

3.2.1 The operating mechanism shall be mechanically and electrically trip-free per IEEE Std. C37.04.

3.2.2 The operating mechanism shall be anti-pumping per IEEE Std. C37.11.

3.2.3 A latch check device shall be provided per IEEE Std. C37.11.

3.2.4 The stored energy mechanism shall be spring charged. Charging motors shall be at a voltage as indicated in ***Supplement Specification CB01PA-S1***. The storage device shall be of sufficient size to permit one (1) complete opening-closing-opening operation at rated short circuit current.

3.2.5 The operating mechanism shall be capable of manual operation upon complete power failure. Any special tooling required to manually operate the breaker shall be supplied.

3.2.6 A mechanically operated operation counter designed to increment on a trip operation shall be supplied.

3.2.7 A readily visible position indicator shall be supplied.

3.2.8 Provisions for a travel analyzer recorder shall be provided.

3.3 GAS SYSTEM

3.3.1 Stainless steel piping and piping fittings is preferred. Manufacturer shall provide the necessary valving to allow maintenance and testing of all density monitors and SF6 pressure switches without removal of SF6 gas or de-energization of the circuit breaker. Manufacturer shall provide piping and a position for a SF6 monitor or provisions for such a device.

3.3.2 A temperature compensated pressure/density gauge(s) shall be supplied for monitoring SF6 gas pressure/density.

3.3.3 Separate from the pressure/density gauge, a temperature compensated “low gas alarm” and “low gas lockout alarm” SF6 gas pressure/density switches shall be provided.

3.3.4 There shall be a shutoff valve between the SF6 enclosure(s) and the temperature compensated pressure/density gauge or switches.

3.3.5 A single fill valve shall be provided to allow for simultaneous filling of all SF6 enclosures.

3.3.6 All fittings shall be self-sealing DILO fittings.

3.3.7 Manufacturer shall supply a diagram indicating the position and function of all valves, monitors, pressure switches and any ancillary equipment in the SF6 piping system.

3.3.8 Each circuit breaker shall be supplied with SF6 gas conforming to ASTM standards of less than 77 ppm moisture content.

3.3.9 Gas enclosures shall be stamped with ASME “U” stamp for pressure vessel documentation purposes.

3.3.10 The tank finish shall be resistant to chipping and shall have a primer coat and a final outer coat of high corrosion resistant material.

3.3.11 Manufacturer shall supply the necessary SF6 gas with the circuit breaker along with all necessary equipment including hoses, adapters, and regulators required to fill the breaker to rated pressure.

3.4 CONTROL CIRCUIT AND WIRING

3.4.1 All control wiring, except BCTs, shall be a minimum of 14 AWG SIS wire, terminated on suitable terminal blocks in the mechanism housing.

3.4.2 AC terminal blocks shall be able to accommodate Purchaser's 6 AWG power cable.

3.4.3 All relay accuracy bushing current transformer (BCT) taps shall be brought out to General Electric Co. shorting type terminal blocks able to accommodate Purchaser's 8 AWG control cable. One extra terminal shall be provided on each BCT terminal block for the purpose of grounding BCTs when changing taps. At a minimum, **relay accuracy BCT wiring shall be 12 AWG SIS**.

3.4.4 All metering accuracy bushing current transformer (BCT) taps shall be brought out to General Electric Co. shorting type terminal blocks able to accommodate Purchaser's 6 AWG control cable. One extra terminal shall be provided on each BCT terminal block for the purpose of grounding BCTs when changing taps. At a minimum, **metering accuracy BCT wiring shall be 10 AWG SIS**.

3.4.5 All other terminal blocks not specified above shall be able to accommodate Purchaser's 8 AWG control cable.

3.4.6 All BCT secondaries shall be shorted to ground prior to shipment.

3.4.7 Double pole fused knife switches shall be furnished for protection of control circuits.

3.4.8 A minimum of ten (10) normally open and ten (10) normally closed spare auxiliary switches shall be furnished in addition to those required for the circuit breaker control circuit.

3.4.9 Two trip coils designed for operation at the control voltage outlined in ***Supplement Specification CB01PA-S1*** shall be provided.

3.4.10 Trip circuit current shall be greater than 2 amps and not exceed 10 amps.

3.4.11 Operating mechanism limit switches shall be provided to prevent operation of the closing coil and closing motor contactor during abnormal or incomplete operation of the operating mechanism

3.4.12 No electrical manual trip or close shall be provided.

3.4.13 The following alarms shall be wired to the terminal board for the purchaser's use:

a. Spring Charge Failure

b. Low Gas Pressure

c. Low Gas Lockout

d. Loss of AC

e. Loss of DC

f. Tank Heater Failure for each phase

3.4.14 The anti-pumping relay (52Y) shall be provided with one spare contact wired to the terminal board for the purchaser's use.

3.4.15 The operating mechanism and all auxiliary components shall be enclosed in a weather tight housing with a lockable door.

3.4.16 The gas density / pressure relay (63G) shall block breaker operation at and below the acceptable low-gas density safe for operating temperature range.

3.4.17 Closing circuit shall have an X relay to limit current to 1 amp.

3.5 ACCESSORIES

3.5.1 The interior of housing shall have a functional 120 VAC light mounted inside.

3.5.2 Each circuit breaker shall have a 120 VAC, 20 A, GFCI outlet. Preferred mounting of the outlet is on the exterior of the circuit breaker in a weatherproof junction box with weatherproof cover. The junction box shall be protected by a metal shroud welded and painted on the exterior of the breaker. Outlet wiring shall be terminated on suitable terminal blocks in the mechanism housing.

3.5.3 Two space heaters, designed for operation on 240 VAC single phase, shall be provided. The heaters shall be low surface temperature or operable at half voltage. One heater shall be continuously energized for condensation control. The second heater shall be thermostatically operated. Manufacturer shall size heaters to provide condensation control and ensure operation at an exterior ambient temperature outlined in ***Supplement Specification CB01PA-S1***.

3.5.4 The construction of the control cabinet and any other housing or compartment for control or operation shall be designed for operation per ***Supplement Specification CB01PA-S1***. If necessary, Manufacturer shall filter, vent, insulate, and/or heat these compartments. Manufacturer shall test and supply information from such tests to indicate proper operation.

3.6 ELECTRICAL CHARACTERISTICS

3.6.1 The circuit breaker electrical ratings shall be per ***Supplement Specification CB01PA-S1***.

3.6.2 The SF6 gas interrupter shall be able to withstand 1.0 times line-to-ground voltage at zero gauge pressure with loss of the SF6 gas insulating medium.

3.6.3 Bushings shall have the same voltage and current rating as the breaker.

3.7 PHYSICAL CHARACTERISTICS

3.7.1 The circuit breaker shall be designed per the Physical Characteristics outlined in ***Supplement Specification CB01PA-S1***.

3.7.2 Breakers shall be sky gray in color and conform to standard color designation ANSI #70.

3.7.3 The breaker shall be furnished with one grounding pad on each leg of the base. The grounding pads shall accommodate Purchaser's 2-hole 2" NEMA grounding pad.

3.7.4 A ground connection tied to the control cabinet ground shall be brought external to the control cabinet.

3.7.5 Bushing terminal shall be aluminum or tin plated bronze 4-hole 4" NEMA terminal pads.

3.7.6 A weatherproof gasket shall be provided on enclosure doors with a drip lip supplied above cabinet doors.

3.7.7 Breaker height shall be sufficient to ensure all energized or live parts are not less than outlined in ***Supplement Specification CB01PA-S1*** when measured to the bottom of frame. The maximum height of the circuit breaker shall be per ***Supplement Specification CB01PA-S1***.

3.7.8 The breaker frame shall be adjustable with the lowest setting within 1" of the minimum height required per **Section 3.7.1**.

3.7.9 The maximum horizontal distance between the centerlines of the outermost phases shall be per ***Supplement Specification CB01PA-S1***.

3.7.10 The structural steel frames shall be hot dipped galvanized per ASTM A123 and A153. A weep hole is required at the lowest point of any box steel construction to prevent water from accumulating inside.

3.7.11 Breaker frame shall withstand service conditions outlined in ***Supplement Specification CB01PA-S1***.

3.7.12 Typical loading calculations shall be supplied with bid.

4. TESTS

4.1 Manufacturer shall provide design test reports for all applicable design tests described in NEMA and IEEE standards including IEEE Std. C37.09, latest revision.

4.2 The circuit breaker shall be subjected to all applicable production tests described in NEMA and IEEE standards including IEEE Std. C37.09, latest revision.

4.3 Purchaser reserves that right to witness factory testing. Manufacturer shall notify Purchaser a minimum of two (2) weeks prior to the start of testing.

4.4 One (1) digital copy of certified test reports shall be supplied for each circuit breaker.

5. DOCUMENTATION

5.1 Information Required with Proposal

Manufacturer shall provide the following for each unique type of Breaker:

5.1.1 Data as indicated in ***Section 13***

5.1.2 Outline drawings showing overall dimensions and relative location of all principal components

5.1.3 General description of type of materials used for principal components

5.2 Documents Required for Approval

Manufacturer shall provide one (1) electronic copy (AutoCAD or Adobe Acrobat Format) of the following for each unique type of breaker:

5.2.1 Outline Drawings

5.2.2 Bushing Outlines

5.2.3 Gas System Diagram

5.2.4 Nameplate Drawings

5.2.5 Schematic Diagrams

5.2.6 Wiring Diagram/Junction Box Layout

5.2.7 BCT Excitation and Saturation Curves

5.2.8 Instruction Manual

5.3 Documentation Required for Record

Approval drawings will not be retained for record purposes. Manufacturer shall provide one (1) electronic copy (AutoCAD or Adobe Acrobat Format) of the following for each Breaker to be used for Purchaser's final records:

5.3.1 Outline Drawings

5.3.2 Bushing Outlines

5.3.3 Gas System Diagram

5.3.4 Nameplate Drawings

5.3.5 Schematic Diagrams

5.3.6 Wiring Diagram/Junction Box Layout

5.3.7 BCT Excitation and Saturation Curves

5.3.8 Instruction Manual

5.3.9 Installation Instructions

5.3.10 Certified Test Reports

One set of instruction books and drawings shall be shipped with the breaker in a weatherproof envelope.

6. <u>TOOLS</u>

Manufacturer shall provide a list of any special tools required for installation, operation, or maintenance with pricing to be included as an adder on the proposal.

7. SPARE PARTS

Manufacturer shall provide a list of recommended spare parts with pricing to be included as an adder on the proposal.

8. SERVICE

The service of a competent installation technician may be required: to inspect the complete installation, to be responsible for the proper installation and operation of the circuit breaker, and to perform all tests that may be necessary. All quotations must include the cost of a competent installation technician as an adder on the proposal.

9. WARRANTY

Manufacturer warrants the equipment furnished is free from defects in material and workmanship and agrees to repair or replace any unit unsuitable for operation or which fails during normal and proper operation. The warranty shall be for a minimum of twelve (12) months from date of initial operation or eighteen (18) months from date of acceptance, whichever comes first.

10. PACKAGING AND DELIVERY

10.1 Manufacturer shall quote FOB site delivery.

10.2 Breaker shall be completely assembled except the structural steel support legs may be shipped separately for bolting on in the field.

10.3 Breaker shall be protected from dirt, road grime, and flying debris during transit. Protection shall be shrink wrap, bubble wrap or other protective covering.

10.4 Bushings shall be wrapped for shipping

10.5 Breaker shall be shipped by open flatbed truck only. There is no freight dock at delivery location.

10.6 Purchaser shall be notified a minimum of three working days before delivery.

10.7 Regular delivery hours are 8:00AM until 3:00PM, Monday thru Friday. Deliveries outside regular hours shall be coordinated with Purchaser and are subject to Purchaser approval.

10.8 Contact for Delivery: **See *Bid Documents***

11. ADDITIONAL INFORMATION

11.1 This standard shall be accompanied by the ***Supplement Specification CB01PA-S1***: Ratings and Technical Requirements completed by Purchaser; and **Section 13**: Specific Information Required with Quotation for Manufacturer to complete.

11.2 Purchaser Proposed Schedule: ***See Supplement Specification CB01PA-S1 and Bid Documents***

11.3 Contact for Technical Questions: **See *Bid Documents***

12. RATINGS AND TECHNICAL REQUIREMENTS

12.1 Purchaser Proposed Technical Requirements: ***Supplement Specification CB01PA-S1***

12.2 Table 1, Table 2, and Table 3 Technical Information: ***See This Page and Next Page***

Table 1

Nominal System Phase-to-phase Voltage (kV)	Rated Maximum Voltage (kV)	Power Frequency Withstand Voltage 10 sec wet (kV)	Chopped Wave Withstand 2 μs to sparkover (kV)	Lightning Impulse Withstand Voltage (kV)
46	48.3	95	322	250
69	72.5	140	452	350
115	121	230	710	550
138	145	275	838	650
161	170	315	968	750
230	245	350	1160	900

Table 2

System Phase-to-phase Voltage (kV) & Amperage (if applicable) (XXXXA)	Minimum Isolated Capacitor Bank Current (A)	Minimum Line Charging Current (A)	Minimum Back to Back Capacitor Bank Current (A)	Minimum Peak Transient Inrush Current (kA)	Minimum Transient Inrush Current Frequency (kHz)
46 (1200A)	630	100	630	20	6.8
46 (2000A)	1000	100	1000	20	6.8
46 (3000A)	1600	100	1600	20	6.8
69 (1200A)	800	100	630	25	3.4
69 (2000A)	1000	100	1000	25	3.4
69 (3000A)	1600	100	1600	25	3.4
115	1200	160	700	16	4.3
138	1200	160	700	16	4.3
161	1200	160	700	20	4.3
230	1200	200	700	20	4.3

Table 3

Rated Maximum Voltage (kV)	Minimum Creep (In)	Minimum Clearance to Live parts (Ft)	Maximum Height (Ft)
48.3	35	10	13
72.5	48	11	14
121	79	12	15
145	92	13	16
170	114	14	17
245	156	15	18

13. SPECIFIC INFORMATION REQUIRED WITH QUOTATION

Manufacturer shall submit the following completed form with their bid. One form shall be used for each item quoted. Failure to complete the form will result in a $1000 addition to the evaluated price.

13.1 General Information

a. Manufacturer		
b. Point of Manufacturer		
c. Domestic Content		%
d. Delivery Date		Weeks ARO
e. Price per Unit (Tax NOT included)	$	
f. Warranty		Months Post Delivery
		Months Post Install
g. Type/Model Number		

13.2 Drawing Transmittal Time

a. Preliminary Drawings		Weeks ARO
b. Wiring Diagram		Weeks ARO
c. Final Outline		Weeks ARO
d. Name Plate		Weeks ARO

13.3 Service Conditions

a. Ambient Temperature Rating		
b. Maximum Altitude		ft
c. Maximum Wind Speed		miles/hr
d. Maximum Ice Loading		inches
e. Maximum Seismic Performance		

13.4 Electrical Characteristics

a.	Maximum Voltage		kV
b.	Rated Operating Duty Cycle		
c.	Power Frequency Withstand Voltage		kV
d.	Lightning Impulse Withstand Voltage		kV
e.	Continuous Current		A
f.	Short-Time Withstand Current		kA
g.	Short-Time Current Duration		sec
h.	Maximum Interrupting Time		Cycles
i.	Short Time 3 Seconds		kA
j.	Out of Phase Switching Current		kA
k.	Close and Latch Current		kA
l.	Capacitive Current Switching Class		
m.	Isolated Capacitor Bank Current		A
n.	Back to Back Capacitor Bank Current		A
o.	Line Charging Current		A
p.	Peak Current Transient Inrush Current		kA
q.	Transient Inrush Current Frequency		kHz
r.	BCT Information (N/A if no Z BCT)	Turns Ratio	Burden/Accuracy
	(i) X (1, 3, 5 terminals) BCT		
	(ii) Y (1, 3, 5 terminals) BCT		
	(iii) Z (1, 3, 5 terminals) BCT (closest to Interrupter)		

r. BCT Information (Continued)	Turns Ratio	Burden/Accuracy
(iv) Z (2, 3, 4 terminals) BCT (closest to Interrupter)		
(v) Y (2, 4, 6 terminals) BCT		
(vi) X (2, 4, 6 terminals) BCT		

13.5 Control Characteristics

a. Tripping Voltage Range		Volts
b. Closing Voltage Range		Volts
c. AC Voltage Range		Volts
d. Trip Current		A
e. Close Current		A

13.6 Physical Characteristics

a. Maximum Height		Inches
b. Maximum Width		Inches
c. Min Height to Live Parts		Inches
d. Insulating Medium		
e. Insulating Medium Weight		Lbs.
f. Net Weight		Lbs.

13.7 Operational Characteristics

a. Operations Between Servicing	
b. Full Fault Operations	
c. Mech. No Load Operations	
d. Continuous Current Operations	

13.8 Added for special tooling per Section 6.

Tool or Device	Price
SF6 and Filling Tools per Section 3.3.11	$ Included
Manual Operating Tools per Section 3.2.5	$ Included
	$
	$

13.9 Adder for recommended spare parts per Section 7.

Spare Part	Price
	$
	$
	$

13.10 Adder for services per Section 8.

Service	Price
	$
	$
	$
	$

13.11 Exemption(s)

13.12 Required Documents Checklist

Manufacturer shall provide the following with quotation:

(i) Design Test Results	
(ii) Instruction Manual	
(iii) Outline Drawing	
(iv) Nameplate Ratings	
(v) Gas System Diagram	
(vi) Schematic Diagrams	

14. REVISION TABLE

Number	Date	By	Reviewed	Description
0	01/02/18	ARS		Original
1	10/04/18	ARS		Updated Section 3.4.11 and 14.1
2	04/19/19	ARS/LAG		Updated BCT, term block, and enclosure requirements, chopped wave values, and added 46kV & 69kV
3	10/02/19	DJS/BAH	KJB	Modified Section 3.4.1, 3.4.3, 3.4.4, 3.4.12, 3.4.13.f, 5.3, Table 2; Added Section 3.4.16 and 3.4.17
4	10/15/21	PJK/BV	RJB	Created CB01PA-S1 Supplemental Spec and Changed section numbering, rearranged sections 12, 13 & 14

MINNESOTA POWER

STANDARD EQUIPMENT SPECIFICATION

OUTDOOR THREE POLE

VACUUM CIRCUIT BREAKERS

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Signature:___________________________________

Typed or Printed Name: Daniel Radloff
Date: August 11, 2022 License No.: 60050

Date	Prep	App
08/11/22	TRM	DJR

Standard Number

CB08PA

(Rev 1)

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14. REVISION TABLE 13

1. SCOPE

This standard covers outdoor, medium-voltage, vacuum circuit breakers (breakers) used on Purchaser's distribution system. The manufacturer shall quote in strict conformance with these specifications. All exceptions to these specifications or any required standard shall be stated and explained in the submitted quotation.

2. REFERENCE STANDARDS

The circuit breaker shall be designed, manufactured, tested, and furnished according to the latest edition, revisions or amendments to the applicable standards of ANSI, NEMA and IEEE including

2.1 IEEE C37.04,

2.2 IEEE C37.09,

2.3 IEEE C37.11

2.4 NEMA Power Circuit Breaker Standard Publication No. SG 4, latest revisions.

2.5 The equipment shall be manufactured to be in compliance with all applicable standards adopted pursuant to the Williams-Steiger Occupational Safety and Health Act of 1970. Any perceived conflicts between this specification and the outlined standards shall be brought to the attention of Purchaser to determine course of action.

3. TECHNICAL REQUIREMENTS

3.1 GENERAL

3.1.1 The circuit breaker shall be designed for the System Characteristics and Service Conditions outlined in ***Supplement Specification CB08PA-S1***.

3.1.2 The breaker shall be furnished complete and ready for operation with operating mechanism, structural steel support, and all accessories necessary for operation.

3.1.3 The breaker shall be of all new materials and of the latest manufacture and design. A rebuilt or used circuit breaker will not be acceptable.

3.2 OPERATING MECHANISM

3.2.1 The operating mechanism shall be mechanically and electrically trip-free per IEEE Std. C37.04.

3.2.2 The operating mechanism shall be anti-pumping per IEEE Std. C37.11.

3.2.3 A latch check device shall be provided per IEEE Std. C37.11.

3.2.4 The stored energy mechanism shall be spring charged or magnetically actuated. Charging motors shall be at a voltage as indicated in ***Supplement Specification CB08PA-S1***. The storage device shall be of sufficient size to permit one (1) complete opening-closing-opening operation at rated short circuit current.

3.2.5 The operating mechanism shall be capable of manual operation upon complete power failure to trip and close the breaker. Any special tooling required to manually operate the breaker shall be supplied.

3.2.6 A mechanically operated operation counter designed to increment on a trip operation shall be supplied.

3.2.7 A readily visible position indicator shall be supplied.

3.2.8 Provisions for a travel analyzer recorder shall be provided.

3.3 INTERRUPTERS

3.3.1 Interrupters shall be porcelain or epoxy weather-case type, vacuum insulated.

3.3.2 Each side of the interrupter shall be capable of line or load connection and will not have a preferred current direction.

3.3.3 The interrupter shall be able to withstand 1.0 times line-to-ground voltage with loss of the vacuum insulating medium.

3.3.4 The vacuum interrupter shall be able to operate normally in the service conditions outlined in ***Supplement Specification CB08PA-S1***.

3.3.5 The tank finish shall be resistant to chipping and shall have a primer coat and a final outer coat of high corrosion resistant material.

3.4 CONTROL CIRCUIT AND WIRING

3.4.1 All control wiring shall be a minimum of 14 AWG SIS wire, terminated on suitable terminal blocks in the mechanism housing.

3.4.2 AC terminal blocks shall be able to accommodate Purchaser's 6 AWG power cable.

3.4.3 All relay accuracy bushing current transformer (BCT) taps shall be brought out to General Electric Co. shorting type terminal blocks able to accommodate Purchaser's 8 AWG control cable. One extra terminal shall be provided on each BCT terminal block for the purpose of grounding BCTs when changing taps. At a minimum, relay accuracy BCT wiring shall be 12 AWG SIS.

3.4.4 All other terminal blocks not specified above shall be able to accommodate Purchaser's 8 AWG control cable.

3.4.5 All BCT secondaries shall be shorted to ground prior to shipment.

3.4.6 Double pole fused knife switches shall be furnished for protection of control circuits.

3.4.7 A minimum of ten (10) normally open and ten (10) normally closed spare auxiliary switches shall be furnished in addition to those required for the circuit breaker control circuit.

3.4.8 Trip circuit current shall be greater than 2 amps and not exceed 10 amps.

3.4.9 Operating mechanism limit switches shall be provided to prevent operation of the closing coil and closing motor contactor during abnormal or incomplete operation of the operating mechanism

3.4.10 No manual trip shall be provided.

3.4.11 The following alarms shall be wired to the terminal board for the purchaser's use:

a. Spring Charge Failure

b. Energy Failure

c. Loss of AC

d. Loss of DC

e. Tank Heater Failure

3.4.12 The anti-pumping relay (52Y) shall be provided with one spare contact wired to the terminal board for the purchaser's use.

3.4.13 The operating mechanism and all auxiliary components shall be enclosed in a weather tight housing with a lockable door.

3.5 ACCESSORIES

3.5.1 The interior of housing shall have a functional 120 VAC light mounted inside.

3.5.2 Each circuit breaker shall have a 120 VAC, 20 A, GFCI outlet. Preferred mounting of the outlet is on the exterior of the circuit breaker in a weatherproof junction box with weatherproof cover. The junction box shall be protected by a metal shroud welded and painted on the exterior of the breaker. Outlet wiring shall be terminated on suitable terminal blocks in the mechanism housing.

3.5.3 Two space heaters, designed for operation on 240 VAC single phase, shall be provided. The heaters shall be low surface temperature or operable at half voltage. One heater shall be continuously energized for condensation control. The second heater shall be thermostatically operated. Manufacturer shall size heaters to provide condensation control and ensure operation at an exterior ambient temperature outlined in ***Supplement Specification CB08PA-S1***.

3.5.4 The construction of the control cabinet and any other housing or compartment for control or operation shall be designed for operation per ***Supplement Specification CB08PA-S1***. If necessary, Manufacturer shall filter, vent, insulate, and/or heat these compartments. Manufacturer shall test and supply information from such tests to indicate proper operation.

3.6 ELECTRICAL CHARACTERISTICS

3.6.1 The circuit breaker electrical ratings shall be per ***Supplement Specification CB08PA-S1***.

3.6.2 The interrupter shall be able to withstand 1.0 times line-to-ground voltage at complete loss of vacuum.

3.6.3 Bushings shall have the same voltage and current rating as the breaker.

3.7 PHYSICAL CHARACTERISTICS

3.7.1 The circuit breaker shall be designed per the Physical Characteristics outlined in ***Supplement Specification CB08PA-S1***.

3.7.2 Breakers shall be sky gray in color and conform to standard color designation ANSI #70.

3.7.3 The breaker shall be furnished with one grounding pad on each leg of the base. The grounding pads shall accommodate Purchaser's 2-hole 2" NEMA grounding pad.

3.7.4 A ground connection tied to the control cabinet ground shall be brought external to the control cabinet.

3.7.5 Bushing terminal shall be aluminum or tin plated bronze 4-hole 4" NEMA terminal pads.

3.7.6 A weatherproof gasket shall be provided on enclosure doors with a drip lip supplied above cabinet doors.

3.7.7 Breaker height shall be sufficient to ensure all energized or live parts are not less than outlined in ***Supplement Specification CB08PA-S1***. when measured to bottom of frame. The maximum height of the circuit breaker shall be per ***Supplement Specification CB08PA-S1***.

3.7.8 The breaker frame shall be adjustable with the lowest setting within 1" of the minimum height required per **Section 3.7.1**.

3.7.9 The maximum horizontal distance between the centerlines of the outermost phases shall be per ***Supplement Specification CB08PA-S1***.

3.7.10 The structural steel frames shall be hot dipped galvanized per ASTM A123 and A153. A weep hole is required at the lowest point of any box steel construction to prevent water from accumulating inside.

3.7.11 Breaker frame shall withstand service conditions outlined in ***Supplement Specification CB08PA-S1***.

3.7.12 Typical loading calculations shall be supplied with bid.

4. TESTS

4.1 Manufacturer shall provide design test reports for all applicable design tests described in NEMA and IEEE standards including IEEE Std. C37.09, latest revision.

4.2 The circuit breaker shall be subjected to all applicable production tests described in NEMA and IEEE standards including IEEE Std. C37.09, latest revision.

4.3 Purchaser reserves that right to witness factory testing. Manufacturer shall notify Purchaser a minimum of two (2) weeks prior to the start of testing.

4.4 One (1) digital copy of certified test reports shall be supplied for each circuit breaker.

5. DOCUMENTATION

5.1 Information Required with Proposal

Manufacturer shall provide the following for each unique type of Breaker:

5.1.1 Data as indicated in ***Section 13***

5.1.2 Outline drawings showing overall dimensions and relative location of all principal components

5.1.3 General description of type of materials used for principal components

5.2 Documents Required for Approval

Manufacturer shall provide one (1) electronic copy (AutoCAD or Adobe Acrobat Format) of the following for each unique type of breaker:

5.2.1 Outline Drawings

5.2.2 Bushing Outlines

5.2.3 Nameplate Drawings

5.2.4 Schematic Diagrams

5.2.5 Wiring Diagram/Junction Box Layout

5.2.6 BCT Excitation and Saturation Curves

5.2.7 Instruction Manual

5.3 Documentation Required for Record

Approval drawings will not be retained for record purposes. Manufacturer shall provide one (1) electronic copy (AutoCAD 2007 or Adobe Acrobat Format) of the following for each Breaker to be used for Purchaser's final records:

5.3.1 Outline Drawings

5.3.2 Bushing Outlines

5.3.3 Nameplate Drawings

5.3.4 Schematic Diagrams

5.3.5 Wiring Diagram/Junction Box Layout

5.3.6 BCT Excitation and Saturation Curves

5.3.7 Instruction Manual

5.3.8 Installation Instructions

5.3.9 Certified Test Reports

One set of instruction books and drawings shall be shipped with the breaker in a weatherproof envelope.

6. TOOLS

Manufacturer shall provide a list of any special tools required for installation, operation, or maintenance with pricing to be included as an adder on the proposal.

7. SPARE PARTS

Manufacturer shall provide a list of recommended spare parts with pricing to be included as an adder on the proposal.

8. SERVICE

The service of a competent installation technician may be required: to inspect the complete installation, to be responsible for the proper installation and operation of the circuit breaker, and to perform all tests that may be necessary. All quotations must include the cost of a competent installation technician as an adder on the proposal.

9. WARRANTY

Manufacturer warrants the equipment furnished is free from defects in material and workmanship and agrees to repair or replace any unit unsuitable for operation or which fails during normal and proper operation. The warranty shall be for a minimum of twelve (12) months from date of initial operation or eighteen (18) months from date of acceptance, whichever comes first.

10. PACKAGING AND DELIVERY

10.1 Manufacturer shall quote FOB site delivery.

10.2 Breaker shall be completely assembled except the structural steel support legs may be shipped separately for bolting on in the field.

10.3 Breaker shall be protected from dirt, road grime, and flying debris during transit. Protection shall be shrink wrap, bubble wrap or other protective covering.

10.4 Bushings shall be wrapped for shipping

10.5 Breaker shall be shipped by open flatbed truck only. There is no freight dock at delivery location.

10.6 Purchaser shall be notified a minimum of three working days before delivery.

10.7 Regular delivery hours are 8:00AM until 3:00PM, Monday thru Friday. Deliveries outside regular hours shall be coordinated with Purchaser and are subject to Purchaser approval.

10.8 Contact for Delivery: **See *Bid Documents***

11. ADDITIONAL INFORMATION

11.1 This standard shall be accompanied by ***Supplement Specification CB08PA-S1***: Ratings and Technical Requirements completed by Purchaser, and **Section 13**: Specific Information Required with Quotation for Manufacturer to complete.

11.2 Purchaser Proposed Schedule: ***See Supplement Specification CB08PA-S1 and Bid Documents***

11.3 Contact for Technical Questions: **See *Bid Documents***

12. RATINGS AND TECHNICAL REQUIREMENTS

12.1 Purchaser Proposed Technical Requirements: ***Supplement Specification CB08PA-S1***

12.2 Table 1, Table 2, and Table 3 Technical Information: ***See Next Page***

Table 1				
System Phase-to-phase Voltage (kV)	Rated Maximum Voltage (kV)	Power Frequency Withstand Voltage 10 sec wet (kV)	Chopped Wave Withstand 2 μs to sparkover (kV)	Lightning Impulse Withstand Voltage (kV)
13.8	15.5	45	142	110
23	25.8	50	194	150
34.5	38	80	258	200

Table 2					
Breaker Continuous Current Rating (A)	Minimum Isolated Capacitor Bank Current (A)	Minimum Line Charging Current (A)	Minimum Back to Back Capacitor Bank Current (A)	Minimum Peak Transient Inrush Current (kA)	Minimum Transient Inrush Current Frequency (kHz)
1200	630	100	630	6	1.2
2000	1000	100	1000	6	0.8
3000	1600	100	1600	6	0.5

Table 3			
Nominal System Class (kV)	Minimum Creep (In)	Minimum Overhead Clearance to Live parts (Ft)	Maximum Height (Ft)
13.8	11	9	12
23	17	9.25	12
34.5	26	9.5	12

13. SPECIFIC INFORMATION REQUIRED WITH QUOTATION

Manufacturer shall submit the following completed form with their bid. One form shall be used for each item quoted. Failure to complete the form will result in a $1000 addition to the evaluated price.

13.1 General Information

a. Manufacturer		
b. Point of Manufacturer		
c. Domestic Content		%
d. Delivery Date		Weeks ARO
e. Price per Unit (Tax NOT included)	$	
f. Warranty		Months Post Delivery
		Months Post Install
g. Type/Model Number		

13.2 Drawing Transmittal Time

a. Preliminary Drawings		Weeks ARO
b. Wiring Diagram		Weeks ARO
c. Final Outline		Weeks ARO
d. Name Plate		Weeks ARO

13.3 Service Conditions

a. Ambient Temperature Rating		
b. Maximum Altitude		ft
c. Maximum Wind Speed		miles/hr
d. Maximum Ice Loading		inches
e. Maximum Seismic Performance		

13.4 Electrical Characteristics

a. Maximum Voltage		kV
b. Rated Operating Duty Cycle		
c. Power Frequency Withstand Voltage		kV
d. Lightning Impulse Withstand Voltage		kV
e. Continuous Current		A
f. Short-Time Withstand Current		kA
g. Short-Time Current Duration		sec
h. Maximum Interrupting Time		Cycles
i. Short Time 3 Seconds		kA
j. Out of Phase Switching Current		kA
k. Close and Latch Current		kA
l. Capacitive Current Switching Class		
m. Isolated Capacitor Bank Current		A
n. Back to Back Capacitor Bank Current		A
o. Line Charging Current		A
p. Peak Current Transient Inrush Current		kA
q. Transient Inrush Current Frequency		kHz
r. BCT Information (N/A if no Y BCT)	Turns Ratio	Burden/Accuracy
(i) X (1, 3, 5 terminals) BCT		
(ii) Y (1, 3, 5 terminals) BCT (closest to interrupter)		
(iii) Y (2, 4, 6 terminals) BCT (closest to interrupter)		

r. BCT Information (Continued)	Turns Ratio	Burden/Accuracy
(iv) X (2, 4, 6 terminals) BCT		

13.5 Control Characteristics

a. Tripping Voltage Range		Volts
b. Closing Voltage Range		Volts
c. AC Voltage Range		Volts
d. Trip Current		A
e. Close Current		A

13.6 Physical Characteristics

a. Maximum Height		Inches
b. Maximum Width		Inches
c. Min Overhead Clearance to Live Parts		Inches
d. Insulating Medium		
e. Net Weight		Lbs.

13.7 Operational Characteristics

a. Operations Between Servicing	
b. Full Fault Operations	
c. Mech. No Load Operations	
d. Continuous Current Operations	

13.8 Added for special tooling per Section 6.

Tool or Device	Price
Manual Operating Tools per Section 3.2.5	$ Included
	$
	$
	$

13.9 Adder for recommended spare parts per Section 7.

Spare Part	Price
	$
	$
	$

13.10 Adder for services per Section 8.

Service	Price
	$
	$
	$
	$

13.11 Exemption(s)

13.12 Required Documents Checklist

Manufacturer shall provide the following with quotation:

(i) Design Test Results	
(ii) Instruction Manual	
(iii) Outline Drawing	
(iv) Nameplate Ratings	
(v) Schematic Diagrams	

14. REVISION TABLE

Number	Date	By	Reviewed	Description
0	10/15/21	PJK/BV	RJB	Original; Created from & reformatted off of existing CB01PA Spec, changed section numbering, rearranged sections 12, 13 & 14
1	8/11/22	TRM	DJR	Revised 3.2.5 to require both manual trip and manual close operation under complete power failure.

STANDARD INSULATOR	TR205 TR202	TR205	TR208	TR210	TR214	TR216	TR286	TR288	TR291	TR304	TR312	TR324	TR391
INSULATOR “H” INCHES	10/7.5	10	14	18	22	30	45	54	62	80	92	106	152
STANDARD MINIMUM CREEP ANSI BUSHINGS	-	11”	17”	26”	35”	48”	79”	92”	114”	140”	205”	220”	318”
SWITCHING SURGE KV 100 x 1000μs	-	75	100	140	190	280	460	540	620	745	870		
CHOPPED WAVE KV 1.15(BIL) @ 3μs	-	120	165	220	270	385	605	715	825	990	1155		
TEST VOLTAGES													
RATED MAX VOLTAGE – kV	8.25	15.5	25.8	38	48.3	72.5	121	145	169	242	242	362	550
NOMINAL VOLTAGE RATING - kV	7.2 & below	14.4	23	34.5	46	69	115	138	161	230	230	345	500
FULL WAVE IMPULSE WITHSTAND kV 1.2 x 50 vs WAVE (kV CREST)	95	110	150	200	250	350	550	650	750	900	1050	1300	1800
RECOMMENDED PHASE SPACING FOR HORN GAP SWITCHES, (VERTICAL & SIDE BREAK) AND FUSES - EXPULSION TYPE (INCHES)	36	36	48	60	72	84	120	144	168	192	216	240	336
RECOMMENDED PHASE SPACING FOR VERTICAL BREAK DISC. SWITCHES, BUS SUPPORTS AND POWER FUSES OTHER THAN EXPULSION (INCHES)	18	24	30	36	48	60	96	108	120	132	156	174	300
SIDE BREAK (HORIZONTAL BREAK) DISC. SW.(S) (INCHES)	30	30	36	48	60	72	108	132	156	192	216	216	-
MINIMUM METAL TO METAL, PHASE TO PHASE DISTANCE FOR ALL DISC. SWITCHES, BUS SUPPORTS AND BUS CONDUCTORS (INCHES)	7	12	15	18	21	31	53	63	72	89	105	119	*1
RECOMMENDED CLEARANCE - PHASE TO GROUND FOR ALL METAL PARTS OR EQUIPMENT (INCHES)	7.5	10	14	18	22	30	47	52.5	61.5	76	90.5	106	*2
ABSOLUTE MINIMUM CLEARANCE - PHASE TO GROUND FOR ALL METAL PARTS OR EQUIPMENT (INCHES)	6	7	10	13	17	25	42	50	58	71	83	104	156
CLEARANCE OVER DRIVEWAYS INSIDE SUBSTATION - MINNESOTA POWER NEW CONSTRUCTION (FEET)	22	22	22	22	22	23	24	25	26	28	30	32	40
MINIMUM OVERHEAD CLEARANCE FROM LIVE PARTS TO GRADE FOR PERSONAL SAFETY (FEET)													
NESC C2 TABLE 124-1	8'-10"	9	9'-3"	9'-6"	10	11	12	13	14	15	16	18	-
RECOMMENDED CLEARANCES FOR NEW CONSTRUCTION	9	9	10	10	10	11	12	13	14	15	16	18'	32
RECOMMENDED CLEARANCES FOR BUS WORK (FEET)	10	10	10	10	12	15	15	16	17	18	18	-	-
HORIZONTAL STRAIN DISCS ANSI CLASS 52-3 PHASE TO GROUND (UNITS)	2	3	3	4	4	6	9	10	12	14	17	19	25
VERTICAL STRAIN DISCS ANSI CLASS 52-3 PHASE TO GROUND (UNITS)	1	2	3	4	4	6	7	8	9	12	13	18	24
VERTICAL STRAIN DISCS ANSI CLASS 52-3 PHASE TO PHASE (UNITS)	2	3	3	4	4	6	9	10	12	14	17	19	25
HORIZONTAL PHASE SPACING FOR TUBULAR & STRAIN BUS (INCHES) – REFER TO NOTE 1	36	36	48	60	72	84	120	144	168	192	216	240	336

REFERENCE DATA: NEMA STANDARDS SG6-8.03 AND HV-1, IEEE/ANSI STD. C37 AND C92, IEEE NESC C2-1993, LAPP INSUL. CAT., EXISTING MP ENGINEERING PRACTICES
*FORBES 500kV SUBSTATION DESIGN FOR 2.8 pu CREST 1250kV (550kV BASE)

*1 RCD TO PLANE 216
*2 RCD TO PLANE 206

NOTES: 1. PHASE SPACING IS CENTER TO CENTER

ENG Daniel J. Radloff	CHK Corbin Ringsred	APPR Daniel J. Radloff	DATE 5-3-23	REV 2	SH 1
minnesota power	SUBSTATION DESIGN STANDARDS CONSTRUCTION & ELECTRICAL CLEARANCE CHART			CL01CD	

MINNESOTA POWER

STANDARD EQUIPMENT SPECIFICATION

FUSELESS OUTDOOR

SHUNT CAPACITOR BANK

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Signature:___________________________________

Typed or Printed Name: Daniel Radloff

Date: July 17, 2023 License No.: 60050

Date	Prep	App
07/06/23	DJR	DJR

Standard Number

CP04PA

(Rev 3)

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14. REVISION TABLE 12

1. SCOPE

This standard covers outdoor, high-voltage, fuseless, shunt capacitor banks used on Purchaser's transmission system. Manufacturer shall quote in strict conformance with these specifications. All exceptions to these specifications or any required standard shall be stated and explained in the submitted quotation.

2. REFERENCE STANDARDS

The capacitor bank components shall be designed, manufactured, tested, and furnished according to the latest edition, revisions or amendments to the applicable standards of ANSI, NEMA and IEEE including:

2.1 IEEE Std. 18

2.2 IEEE Std. C57.13

2.3 The equipment shall be manufactured to be in compliance with all applicable standards adopted pursuant to the Williams-Steiger Occupational Safety and Health Act of 1970. Any perceived conflicts between this specification and the outlined standards shall be brought to the attention of Purchaser to determine course of action.

3. TECHNICAL REQUIREMENTS

3.1 GENERAL

3.1.1 The capacitor bank shall be designed for the System Characteristics and Service Conditions outlined in ***Supplement Specification CP04PA-S1***.

3.1.2 All capacitor bank components shall be of all new materials and of the latest manufacture and design. Rebuilt or used equipment will not be acceptable.

3.1.3 Manufacturer shall propose a complete capacitor bank and its system configuration. The system shall include all necessary support structures, the individual capacitors, instrumentation, power wiring and protection scheme. The individual capacitors and bank shall be designed as a complete system by manufacturer.

3.2 ELECTRICAL CHARACTERISTICS

3.2.1 The capacitor bank electrical ratings shall be per ***Supplement Specification CP04PA-S1***.

3.2.2 The capacitor bank shall be single point grounded. Manufacturer shall provide a connection point to allow for extension to the Purchaser's ground grid.

3.2.3 Capacitor cans shall be single phase, "all-film" type.

3.2.4 Capacitor elements inside each can/unit shall be assembled with a folded edge at each end of the element.

3.2.5 Capacitor cans shall be rated such that the applied voltage is 90% of their nominal rating when installed at nominal system voltage. For example, a 15kV rated capacitor can would be nominally energized at 13.5kV.

3.2.6 A current transformer connected from the neutral to ground shall be provided for the protection scheme. The current transformer shall be rated for at least 50% of the nominal phase current and have protective gap or arrester installed across the primary. The thermal rating should be equal to or greater than the current rating outlined in ***Supplement Specification CP04PA-S1***, including harmonics. The voltage rating for the CT's used at the neutral end of the grounded wye bank should be greater than or equal to 0.2 times the system line to line voltage.

3.2.7 A potential transformer, connected across the neutral capacitor at the neutral end of each phase, shall be provided. Transformer secondary shall be 240V and fuse protected.

3.2.8 Manufacturer shall design the capacitor bank such that loss of four series sections in a parallel group shall not exceed 105% of rated voltage on the remaining series elements in that series group when the capacitor bank is operated at nominal system voltage.

3.2.9 The capacitor bank shall be designed to mount current limiting reactors, sized per ***Supplement Specification CP04PA-S1***, in series with each phase atop the bank, at the phase voltage connection point.

3.2.10 If required per ***Supplement Specification CP04PA-S1***, current limiting reactors shall be supplied with the capacitor bank.

3.3 PHYSICAL CHARACTERISTICS

3.3.1 The capacitor bank shall be designed per the Physical Characteristics outlined in ***Supplement Specification CP04PA-S1***.

3.3.2 All racks shall have 9 foot substructures. All phase and line connections shall be at least 10 feet above the base of the structure. Physical clearance from all components between each phase or rack of the capacitor bank shall be a minimum of 78 inches.

3.3.3 Provisions shall be designed to allow the enlargement or reduction of the capacitor bank per ***Supplement Specification CP04PA-S1***. This shall be accomplished in step increments as noted in ***Supplement Specification CP04PA-S1*** by the removal of individual cans without alteration of the structure or instrumentation.

3.3.4 Dielectric fluid to be non-PCB.

3.3.5 All ferrous parts exposed to the weather and subject to corrosion shall be galvanized.

3.3.6 The line terminals shall be furnished with a standard aluminum or tin-plated bronze 4" NEMA 4-hole terminal pads.

3.3.7 Capacitor bank junction boxes shall have a vertical hinge and single pad-lockable handle. Junction box shall be able to accommodate Purchaser's 3" conduit penetration. All conduit penetrations shall be in bottom of box. Junction box shall be sized to allow for at least 4" of horizontal separation between all components. All components shall have at least 4" of horizontal and vertical separation from the junction box walls.

4. TESTS

4.1 Manufacturer shall provide design test reports for all applicable design tests described in NEMA and IEEE standards including IEEE Std. 18 and IEEE Std. C57.13, latest revision.

4.2 Capacitor cans shall be subjected to all applicable production tests described in NEMA and IEEE Standards including IEEE Std. 18, latest revision.

4.3 In addition to the applicable production tests described in Section 4.2 above, each capacitor shall withstand an **AC** test voltage of **2.3 times rated (rms) voltage** for at least **10 seconds** for the short-time overvoltage test per section 7.2.1 of IEEE Std.18-2012.

4.4 Instrument transformers shall be subjected to all applicable production tests described in NEMA and IEEE Standards including IEEE Std. C57.13, latest revision.

4.5 Purchaser reserves that right to witness factory testing. Manufacturer shall notify Purchaser a minimum of two (2) weeks prior to the start of testing.

4.6 One (1) digital copy of certified test reports shall be supplied for each capacitor bank component.

5. DOCUMENTATION

5.1 Information Required with Proposal

Manufacturer shall provide the following for each unique type of capacitor bank:

5.1.1 Data as indicated in ***Section 13***.

5.1.2 Outline drawings showing overall dimensions and relative location of all principal components.

5.1.3 General description of type of materials used for principal components.

5.2 Documents Required for Approval

Manufacturer shall provide one (1) electronic copy (AutoCAD and Adobe Acrobat Format) of the following for each unique capacitor bank:

5.2.1 Outline Drawings

5.2.2 Junction Box Layout

5.2.3 Nameplate Data

5.2.4 Instruction Manual

5.3 Documentation Required for Record

Approval drawings will not be retained for record purposes. Manufacturer shall provide one (1) electronic copy (AutoCAD 2007 or Adobe Acrobat Format) of the following for each capacitor bank to be used for Purchaser's final records:

5.3.1 Outline Drawings.

5.3.2 Junction Box Layout

5.3.3 Nameplate Data

5.3.4 Instruction Manual

5.3.5 Installation Instructions

5.3.6 Certified Test Reports

One set of instruction books and drawings shall be shipped with the capacitor bank in a weatherproof envelope.

6. TOOLS

Manufacturer shall provide a list of any special tools required for installation, operation, or maintenance with pricing to be included as an adder on the proposal.

7. SPARE PARTS

7.1 10% spare capacitor units shall be provided for both main bank and protective capacitor units.

7.2 Manufacturer shall provide a list of other recommended spare parts with pricing to be included as an adder on the proposal.

8. SERVICE

The service of a competent installation technician may be required: to inspect the complete installation, to be responsible for the proper installation and operation of the capacitor bank, and to perform all tests that may be necessary. The cost of a competent installation technician shall be included as an adder on the proposal.

9. WARRANTY

Manufacturer warrants the equipment furnished is free from defects in material and workmanship and agrees to repair or replace any unit unsuitable for operation or which fails during normal and proper operation. The warranty shall be for a minimum of twelve (12) months from date of initial operation or eighteen (18) months from date of acceptance, whichever comes first.

10. PACKAGING AND DELIVERY

10.1 Manufacturer shall quote FOB site delivery.

10.2 Capacitor bank components shall be securely strapped to a hardwood pallet(s) rated to support its weight.

10.3 Capacitor bank components shall be protected from dirt, road grime, and flying debris during transit. Protection shall be shrink wrap, bubble wrap or other protective covering.

10.4 Capacitor bank components shall be shipped by open flatbed truck only. There is no freight dock at delivery location.

10.5 Purchaser shall be notified a minimum of three working days before delivery.

10.6 Regular delivery hours are 8:00AM until 3:00PM, Monday thru Friday. Deliveries outside regular hours shall be coordinated with Purchaser and are subject to Purchaser approval.

10.7 Contact for Delivery: **See *Bid Documents***

11. ADDITIONAL INFORMATION

11.1 This standard shall be accompanied by the ***Supplement Specification CP04PA-S1***: Ratings and Technical Requirements, and **Section 13**: Specific Information Required with Quotation for Manufacturer to complete.

11.2 Purchaser Proposed Schedule: ***See Supplement Specification CP04PA-S1 and Bid Documents***

11.3 Contact for Technical Questions: **See *Bid Documents***

12. RATINGS AND TECHNICAL REQUIREMENTS

12.1 Purchaser Proposed Technical Requirements: ***Supplement Specification CP04PA-S1***

12.2 Tables 1 & 2 Technical Information: ***Next Page***

Table 1

System Phase-to-phase Voltage (kV)	Rated Maximum Voltage (kV)	Lightning Impulse Withstand Voltage (kV)	Neutral Current Transformer Minimum BIL	Phase Spacing (Live Parts to Live Parts) (in.)
69	72.5	350	110	31
115/121*	121	550	150	53
230	242	900	250	89
345	362	1300	350	119
500	535	1800	550	216

* 115 kV is calculated at 121 kV

Table 2

System Phase-to-phase Voltage (kV)	Capacitor Can Rating (kV)	Capacitor Can Size (kVAR)	Rated Bank Voltage (KV)	Expansion Increments (kVAR)	Derating Factor
69	10.5	400	72.75	4800	5.4%
115/121*	18.4	400	127.48	4800	5.35%
230	17.8	650	264.64	4800	7.2%
345	17.8	650	369.97	4800	7.2%
500	17.8	650	554.95	4800	11%

* 115 kV is calculated at 121 kV

Table 3						
System Phase-to-phase Voltage (kV)	**69kV**	**115/121 kV***	**230 kV**	**345 kV**	**500 kV**	**Number of strings per phase**
MVAR at Nominal Voltage	8.64	8.65	27.13	40.70	56.99	2
	12.96	12.97	40.70	61.05	85.48	3
	17.27	17.30	54.26	81.39	113.97	4
	21.59	21.62	67.83	101.74	142.47	5
	25.91	25.95	81.39	122.09	170.96	6
	30.23	30.27	94.96	142.44	199.45	7
	34.55	34.60	108.52	162.79	227.95	8
	38.87	38.92	122.09	183.14	256.44	9
	43.18	43.24	135.66	203.48	284.12	10

* 115 kV is calculated at 121 kV

13. SPECIFIC INFORMATION REQUIRED WITH QUOTATION

Manufacturer shall submit the following completed form with their bid. One form shall be used for each unique item quoted. Failure to complete the form will result in a $1000 addition to the evaluated price.

13.1 General Information

a. Manufacturer		
b. Point of Manufacturer		
c. Point of Shipment		
d. Domestic Content		%
e. Delivery Date		Weeks ARO
f. Price per Unit (Tax NOT included)	$	
g. Type/Model Number		

13.2 Drawing Transmittal Time

a. Preliminary Drawings		Weeks ARO
b. Final Outline		Weeks ARO
c. Nameplate		Weeks ARO

13.3 Service Conditions

a. Ambient Temperature Rating		
b. Maximum Altitude		ft
c. Maximum Wind Speed		miles/hr
d. Maximum Ice Loading		inches
e. Maximum Seismic Performance		

13.4 Electrical Characteristics

a. Reactive Power Rating (Installed)		kVAR

b. Reactive Power Rating (Maximum)		kVAR
c. Capacitor Units in Series		
d. Series Groups in Parallel (Installed)		
e. Series Groups in Parallel (Maximum)		
f. Configuration		
g. Rated Voltage		kV
h. Overall Lightning Impulse Level		kV
i. Bank Capacitor Can Ratings		
(i) Reactive Power Rating		kVAR
(ii) Rated Voltage		kV
(iii) Rated Capacitance		μF
(iv) Lightning Impulse Level		kV
(v) Unit Failure Rate		
j. Protective Capacitor Can Ratings		
(i) Reactive Power Rating		kVAR
(ii) Rated Voltage		V
(iii) Rated Capacitance		μF
(iv) Lightning Impulse Level		kV
k. Potential Transformer Ratings		
(i) Manufacturer		
(ii) Style/Model		
(iii) Rated Voltage		kV
(iv) Ratio		

(v) Lightning Impulse Level		kV
l. Current Transformer		
(i) Manufacturer		
(ii) Style/Model		
(iii) Rated Voltage		kV
(iv) Ratio		
(v) Thermal Rating Factor		
(vi) Lightning Impulse Level		kV
(vii) Accuracy		
m. Current Limiting Reactor	If Required	
(i) Manufacturer		
(ii) Model/Style		
(iii) Rated Voltage		kV
(iv) Rated Current		A
(v) Rated Short Time Current (3 sec)		kA
(vi) Inductance		mH
(vii) Lightning Impulse Level		kV

13.5 Physical Characteristics

a. Width		in
b. Length		in
c. Height		in
d. Bank Capacitor Can Weight		lbs
e. Current Limiting Reactor Weight		lbs

f.	Overall Bank Weight (per phase)		lbs
g.	Overall Volume of Oil		gal
h.	Maximum Primary Terminal Load		lbs

13.1 Added for special tooling per Section 6

Tool or Device	Price
	$
	$
	$
	$

13.2 Adder for recommended spare parts per Section 7.

Spare Part	Price
10% Spare Main Bank Capacitor Cans	$
10% Spare Main Bank Capacitor Cans	$
	$
	$
	$

13.3 Adder for services per Section 8.

Service	Price
	$
	$
	$
	$

13.4 Exemption(s)

13.5 Required Documents Checklist

Manufacturer shall provide the following with quotation:

(i) Design Test Results	
(ii) Instruction Manual	
(iii) Data Sheets	
o Capacitor Cans	
o Current Transformer	
o Potential Transformer	
(iv) Outline Drawing	
(v) Nameplate Ratings	
(vi) Unbalance Projection Sheet	

14. REVISION TABLE

Number	Date	By	Reviewed	Description
0	01/02/18	ARS		Original
1	01/17/20	DJS	KJB	Added detail to 3.2.3, 3.2.4, 3.2.5, 3.3.3, 4.3 and updated section 13.
2	12/16/21	MAR/BV	RJB	Reformat of existing CP04PA Spec, changed section numbering, rearranged sections 12 & 13. Revised Tables 1 & 2 and minor miscellaneous updates.
3	07/06/23	DJR	CKR	Updated Tables & 3.3.2 Clearance between banks

Wind Substation

MINNESOTA POWER

STANDARD SPECIFICATION

CONTROL & FIBER OPTIC CABLE INSTALLATION

Date	Prep
2/13/2020	DJS

Standard Number

EL02CS

(Rev 0)

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9. TABLES 11

1. SCOPE

Insulated cable, conductors, conductor accessories and fiber optic cable shall be furnished and installed in accordance with the requirements of this specification.

Installation shall be defined to include placement, terminating conductors, coiling and taping of spare conductors, identification, testing, and verification of each circuit, cable, and conductor. Installation of cable in existing trays or cable trench shall also include removal and replacement of existing cable tray or cable trench covers as necessary.

Terminating a conductor shall include installing cable termination kits for shielded cable, attaching the conductor at its designated location and insulating the entire connection where specified or required by the application.

2. REFERENCE STANDARDS

2.1 SPECIFICATIONS

2.1.1 The cable furnished shall conform to Minnesota Power Standard Equipment Specification CA0P1A Flame Retardant Power & Control Cable.

2.1.2 Where no code or standard governs, the Contractor shall adopt the manufacturer's recommendations for cable installation with Purchaser's approval.

3. TECHNICAL REQUIREMENTS

3.1 GENERAL

3.1.1 All conductor accessories including connectors, terminations, insulating materials, support grips, markers, and cable ties shall be furnished and installed by the Contractor.

3.1.2 Manufacturer's installation instructions shall be obtained for cable accessories. These instructions shall be in the possession of the craftsmen while installing the accessories and shall be available to the Construction Manager for reference.

3.2 TERMINAL CONNECTORS

3.2.1 Terminal connectors for conductors 8 AWG and larger shall be pressure or bolted clamp type, Burndy Qiklug, Varilug, or acceptable equal; or compression type, Burndy Type YAV or YA (long barrel), Panduit Type LCA or LCC, or acceptable equal. Acceptable connectors included with Purchaser furnished equipment may be used.

3.2.2 Terminal connectors for conductors smaller than 8 AWG shall be compression type connectors properly sized for the conductor and the terminal. The connectors shall be constructed of fine grade high conductivity copper in accordance with QQ-C-576 and shall be tin plated in accordance with MIL-T-l0727. The interior surface of the connector wire barrel shall be serrated, and the exterior surface of the connector wire barrel shall be provided with crimp guides.

3.2.3 Uninsulated ring tongue lugs shall be used for all terminations except where compression terminals exist.

3.2.4 Where compression terminals exist preinsulated ferrule connectors are to be used and shall include a vinyl insulating sleeve, color coded to indicate conductor size. Preinsulated ferrule connectors shall include a metallic support sleeve bonded to the vinyl insulating sleeve and designed to grip the conductor insulation. Insulated twin ferrules shall be used if two conductors are to be terminated on a compression terminal.

3.2.5 Ring type connectors shall be manufactured by AMP, 3M, Panduit, or acceptable equal. Ferrule type connectors shall be Panduit or acceptable equal.

3.3 TERMINAL BLOCKS

3.3.1 Terminal blocks for conductors rated 600 volts or less shall be strap screw type, rated 600 volts, shall have 20 percent more terminal points than the quantity of conductors requiring termination, and shall have white marking strips. Terminal blocks shall be sized for the conductor being terminated.

3.4 CRIMPING TOOLS

3.4.1 Crimping tools used to secure conductors in compression type connectors or terminal lugs shall be those made for that purpose and for the conductor sizes involved.

3.4.2 The crimping tools shall accurately crimp the connector barrel and shall accurately crimp the conductor insulation support sleeve where provided.

3.4.3 Crimping tools shall be provided with guides to position connectors in the tool, shall be provided with stops to prevent over crimping, and shall be of a type which prevents the tools from opening until the crimp action is completed.

3.4.4 Crimping tools shall be a product of the connector manufacturer or shall be as recommended by the connector manufacturer and acceptable to the Purchaser's Engineer for use with the connectors.

3.4.5 The Contractor shall establish and maintain a tool certification program to ensure that crimping tools are kept in accurate operating condition.

3.5 INSULATING MATERIALS

3.5.1 600 Volt Cable. Insulating materials for terminal connectors or compression type connectors shall consist of varnished cambric tape, rubber tape, and vinyl tape. Taping materials shall be as listed below or acceptable equal:

3.5.1.1 Varnished Cambric Tape--3M Company Irvington 2520.

3.5.1.2 Rubber Tape--3M Company Scotch 130C.

3.5.1.3 Vinyl Tape--3M Company Scotch 33+.

3.6 CONDUCTOR AND CABLE MARKERS

3.6.1 Markers shall be furnished by the Contractor.

3.6.2 Markers for wire and cable circuits shall be of an opaque nylon material arranged to include a marker board, nonreleasing holding device, and cable fastening tail. The marker board shall not be less than 3/4 inch wide, 2-1/2 inches long, and 15 mils thick and shall be Panduit Corp. Part No. MP250 marker plates or acceptable equal. One side shall be roughened to hold black nylon marking ink from a fine tip pen similar to Thomas & Betts Company "TY-RAP" marking pen, Catalog No. WTl63M-l, or Panduit Corp. Part No. PFX-0 marking pen. Identification shall be permanent and waterproof. The holding device shall be designed to allow the fastening tail to pass around the cable through the holding device and prevent the removal of the tail without cutting it loose from the marker.

3.6.3 The cable markers shall be approved permanent weatherproof tags for circuit identification

3.6.4 The Contractor shall identify the ends of all cables with the associated cable number as identified in the Cable List drawing. Cables shall also be identified at the entrance and exit of manholes and conduits.

3.6.5 Each cable run in a wiring trough, whether single, multi-conductor or multiple single conductor cables, shall be identified at its point of entrance to and exit from the wiring trough and at each manhole with permanent cable markers.

3.7 CABLE TIES

3.7.1 Lacing materials for field installed cable shall be nonreleasing weather-resistant black nylon ties manufactured by Thomas & Betts Company, Elizabeth, New Jersey; Panduit Corp., Tinley Park, Illinois; 3M Company; or acceptable equal.

3.8 ARCPROOFING MATERIAL

3.8.1 Material for arc proofing cable shall be an unsupported intumescent self-extinguishing elastomer tape, 3M Company Scotch Brand No. 77 or acceptable equal, and a pressure sensitive silicone adhesive backed glass cloth holding tape, 3M Company Scotch Brand No. 69 or acceptable equal.

3.9 CABLE SHIELD GROUNDING

3.9.1 All control cable shields need to be grounded using AMP/TYCO Termi-Foil (non-insulated) Cat # 2-327254-4 or approved equal.

3.9.2 Cable shield grounding shall be installed on one end of each shielded control cable. If a cable terminates in the EEE Termination Cabinet then the EEE Termination Cabinet shall also be the grounding location for the cable shield.

4. CONTROL CABLE INSTALLATION

4.1 CABLE PLACMENT

4.1.1 The installation of all cable and terminations shall be as shown on the Cable and Conduit List, SC01CS - Substation Construction Specification, Purchaser's Drawings and this specification. Interpanel connections are those between the panels as listed in the Bill of Material. Cable shall not be handled when the cable temperature is below the minimum temperature recommended by the manufacturer. If cable heating is required prior to placement, the cable shall be stored in a heated building in accordance with the manufacturer's recommendations for at least 24 hours. Cable shall be placed the same day it is removed from heated storage.

4.1.2 Contractor shall pull sufficient length of each cable to permit a neat arrangement of all entering cables, with leads formed and tied or clamped as each conductor is brought to its terminal connections. No tangle box work will be accepted.

4.1.3 If at any time during the progress of the work the Contractor finds raceways which appear inadequate to accommodate the assigned cable, Contractor shall notify the Construction Manager at once and shall discontinue any further work on the questionable raceway until advised by the Construction Manager as to proceed.

4.1.4 Immediately prior to the placement of each cable or cable group, the raceway route to be followed shall be inspected and ascertained to be complete in installation and free of all materials detrimental to the cable or its placement.

4.1.5 All cable assigned to a particular duct or conduit shall be grouped and pulled in simultaneously using cable grips and acceptable lubricants.

4.1.6 All cable shall be carefully checked both as to size and length before being pulled into conduits or ducts. Cable pulled into the wrong conduit or duct or cut too short to rack, train, and splice as specified herein shall be removed and replaced by and at the expense of the Contractor. Cable removed from one conduit or duct shall not be pulled into another conduit or duct, unless approved by Purchaser's Substation Engineering.

4.2 CABLE IN TRAYS

4.2.1 All cable shall be carefully laid in or pulled through the tray system so that neither the cable nor the trays are damaged. Cable may be laid along the side of the tray system during placement provided it is protected from dirt, water, oil, or other detrimental materials and from mechanical injury. Cable shall be cut sufficiently long to conform to the contour of the trays, with particular attention paid to vertical inside bends. All excessive slack shall be removed from the cable so that it lies parallel to the sides of the trays. Multiple single conductor cable which constitutes a single power circuit shall be grouped together to minimize magnetic influence on other cable in the area. The cable shall be tied to the trays with nylon ties at l0 foot intervals to hold it in place. Cable clamps designed for holding the cable inside the trays shall be installed at all vertical bends.

4.3 CABLE IN MANHOLES

4.3.1 Cable shall be supported at all times without short bends or excessive sags and shall not be permitted to lie on the manhole floor.

4.3.2 Cable ends must not be submerged.

4.3.3 Cable racks or trays shall be provided for permanent support.

4.3.4 Temporary support required during placement shall be with rope slings, timbers, or alternate method acceptable to the Construction Manager.

4.4 CABLE PULLING

4.4.1 Fishing and pulling shall be done with flexible round metal tape, CO^2 propelled polyethylene cord, nylon rope, or manila rope.

4.4.2 All control or power cable to be installed in a particular conduit shall be installed at one time.

4.4.3 Unless specified otherwise or acceptable to the Construction Manager, cable shall not be pulled in a single pull through two sections of Engineer-designed raceway connected by a manhole or pull box. Cable shall be pulled out at each manhole and pull box to the length required for termination. Prior to repulling of the pulled out cable, the cable shall be thoroughly inspected, cleaned, and relubricated. Damaged cable shall be removed and replaced by and at the expense of the Contractor.

4.4.4 Cable may be pulled in a single pull through two sections of Engineer-designed raceway connected by a manhole or pull box only if it can be determined by calculation to the satisfaction of the Construction Manager, that the pulling tension will not exceed the maximum tension allowed by the cable manufacturer.

4.4.5 Factory installed pulling eyes shall be used for pulling cable where they are available. Woven wire cable grips shall be used to pull all single conductor cable 2/0 AWG and larger, where pulling eyes are not available, and all multi-conductor cable. Pulling loops shall be used to pull single conductor cable smaller than 2/0 AWG. All sharp points and edges on the hardware attaching the pulling rope to the cable shall be taped to prevent snagging or damaging the raceway.

4.4.6 When a cable grip or pulling eye is used for pulling, the area of the cable covered by the grip or seal plus 6 inches shall be cut off and discarded when the pull is completed. When pulling loops are used, the entire loop shall be cut off and discarded when the pull is completed.

4.4.7 As soon as the cable is pulled into place, the pulling eyes, cable grips, or pulling loops shall be removed and any cable which was sealed shall be resealed.

4.4.8 A reliable nonfreezing type of swivel, or swivel connection, shall be inserted between the pulling rope and the cable pulling eye, grip, or loop to prevent twisting under strain.

4.4.9 A 4 inch or larger flexible feeding tube, with a removable nozzle sized to fit the ducts, shall be used in pulling all underground cable. The feeding tube shall be long enough to extend from the duct entrance to the outside of the manhole and shall be so arranged that it will be impossible for the cable to drag across the edge of the manhole ring or any other damaging surface. The bending radius of the tube shall not be less than the minimum bending radius of the cable specified in this section under the article titled Cable Bends.

4.4.10 Only lubricants recommended by the cable manufacturer and acceptable to the Construction Manager shall be used. Lubricants shall be applied liberally and continuously during the pull.

4.4.11 The outside of each cable reel shall be carefully inspected and protruding nails, fastenings, or other objects which might damage the cable shall be removed. A thorough visual inspection for flaws, breaks, or abrasions in the cable sheath shall be made as the cable leaves the reel, and the pulling speed shall be slow enough to permit this inspection. Damage to the sheath or finish of the cable shall be sufficient cause for rejecting the cable. Cable damaged in any way during installation shall be replaced by and at the expense of the Contractor.

4.4.12 The pulling tension of any cable shall not exceed the maximum tension recommended by the cable manufacturer. Pulling mechanisms of both the manual and power types used by the Contractor shall have the rated capacity in tons clearly marked on the mechanism. Whenever the capacity of the pulling mechanism exceeds the recommended pulling tension of the cable as given by the cable manufacturer, a dynamometer shall be used to show the tension on the cable and the indicator shall be constantly watched. If any excessive strain develops, the pulling operation shall be stopped at once and the difficulty determined and corrected and approved by Purchaser.

4.4.13 To avoid insulation damage from excessive sidewall pressure at bends, the pulling tension in pounds at a bend shall not exceed 300 times the radius of the bend in feet.

4.4.14 Tape shielded, flat tape armored, and wire armored cable shall not be bent to a radius of less than 12 times the overall cable diameter. All other cables shall not be bent to a radius of less than eight times the cable diameter.

4.5 CABLE SUPPORTS

4.5.1 All cable supports and securing devices shall have bearing surfaces located parallel to the surfaces of the cable sheath and shall be installed to provide adequate support without deformation of the cable jackets or insulation.

4.5.2 Adequate cable end lengths shall be provided and properly placed in junction boxes and manholes to avoid longitudinal strains and distorting pressures on the cable at conduit bushings and duct end bells.

4.5.3 Final inspection shall be made after all cable is in place and, where supports or raceway fittings deform the cable jacket, additional supports shall be provided as directed by the Construction Manager. Additional cable protection such as a wrapping of light rubber belting, friction tape, or similar material shall be provided where required.

4.5.4 Cable in vertical runs shall be supported by woven wire grips in accordance with the NEC requirements, except that the distance between supports shall conform to Section 9 Table 1.

4.5.5 Where cable trays are not specified in man-holes, cable racks shall be furnished and installed according to the drawings and as required to provide the proper cable support. Cable racks shall be installed on spacings of not greater than 36 inches and shall be bolt secured to permanent wall surfaces with self-drilling anchors or continuous slot concrete inserts.

4.6 MISC

4.6.1 All spare conductors of a multi-conductor cable shall be left at their maximum lengths for possible replacement of any other conductors in the cable and to reach the furthest point of the junction box, panel board, or control cabinet. Each spare conductor shall be neatly looped back and then taped to the conductors being used .

4.6.2 Nylon ties shall be used to neatly lace together conductors at six inch intervals entering switchboards and similar locations after the conductors have emerged from their supporting raceway or conduit and before they are attached to terminals.

4.6.3 The Contractor shall thoroughly inspect cable of all types during installation to ensure against punctures or any other physical damage to insulation or conductor. Care shall be taken to avoid sharply bending or kinking conductor, damaging insulators or stressing cable beyond manufacturer's recommendations in pulling.

4.6.4 Damaged or out of place cable shall be replaced at Contractor's expense.

4.6.5 Each cable with an aluminum conductor shall be kept sealed except when termination and splicing work is being performed.

The ends of all cables shall be sealed with heat shrinkable caps. Cap sizes shall be as recommended by the cap manufacturer for the cable OD and insulation. Caps shall contain sufficient adhesive that shrinkage of the cap during application results in formation of a positive water-tight seal capable of withstanding complete immersion or total exposure without permitting the entrance of moisture. Heat shrinkable caps shall be "Thermofit" as manufactured by Raychem Corporation or acceptable equal.

Before and after pulling, the leading end seal of each length of cable shall be examined and repaired if necessary. All cut cable ends shall be promptly sealed after cutting except those to be spliced or terminated immediately.

4.7 SPLICES

4.7.1 No splices shall be made in conductors for instrument circuits or control circuits.

4.7.2 Shields may be spliced where necessary to permit connection to the station ground.

4.8 TERMINATIONS

4.8.1 Train cable in place and cut squarely to required length. Avoid sharp bends.

4.8.2 Remove necessary amount of cable jacket and insulation without damage to the conductor.

4.8.3 Install terminals or terminal connectors as required, ensuring a firm metal-to-metal contact.

4.8.4 Insulate each connection of cable to an insulated conductor (whether cable, bus, or equipment bushing). The insulation shall cover all exposed surfaces of the conductors; the insulation voltage level of the completed termination shall be not less than the insulation voltage level of the connected conductors.

4.8.5 Control cable terminations shall be made in accordance with Purchaser wiring schematics furnished to the Contractor.

4.8.6 Terminal connectors shall meet Section 3.2 of this specification.

4.9 INSULATION OF 600 VOLT CABLE CONNETIONS

4.9.1 Where connections of cable rated 600 volts or less require insulation, all exposed conductor and connector surfaces shall be covered with tape in accordance with the following:

4.9.1.1 One half-lapped layer of varnished cambric tape.

4.9.1.2 A minimum of three half-lapped layers of rubber tape, elongated not more than 20 percent, applied over the varnished cambric tape.

4.9.1.3 A minimum of three half-lapped layers of vinyl tape applied over the rubber tape. The vinyl tape shall extend a minimum of two cable diameters over the cable jacket and a similar distance over the insulation of the conductor to which the cable is connected.

5. <u>CONTROL CABLE TESTS</u>

5.1 GENERAL

5.1.1 All insulated conductors shall be electrically tested after placement.

5.1.2 All circuits, including lighting circuits, shall be tested with the circuit complete except for connections to equipment. All splices, stress cones on shielded cable, and terminal connector attachments shall be complete prior to testing.

5.1.3 Any circuit failing to test satisfactorily shall be replaced or repaired and then retested.

5.1.4 All equipment and labor required for testing shall be furnished by the Contractor.

5.2 CONTINUITY AND IDENTIFICATION TETS

5.2.1 All insulated conductors shall be tested for continuity and conductor identification.

5.2.2 Continuity tests shall include all tests necessary to confirm that each conductor is continuous throughout its entire length.

5.2.3 Identification tests shall include all tests necessary to confirm that the conductor being investigated originates and terminates at the locations designated on the drawings.

5.3 INSULATION TESTS

5.3.1 Resistance from ground provided by the insulation on all field installed insulated conductors shall be measured.

5.3.2 All insulated conductors except supervisory and communication cable, rated 600 volts and below shall be tested with a 1000 volt megger or an equivalent testing device. Insulation resistance measurements shall be made between each conductor and ground and between each conductor and all other conductors of the same circuit. Minimum acceptable resistance values shall be approximately 500 megohms.

5.3.3 All insulated conductors of supervisory and communication cable shall be tested with a 500 volt megger or an equivalent testing device. Insulation resistance measurements shall be made between each conductor and the cable shielding tape and between the two conductors in each pair. Minimum acceptable resistance values shall be 500 megohms divided by the actual cable length in miles.

6. FIBER-OPTIC CABLE

6.1 INSTALLATION

6.1.1 Contractor shall install Purchaser provided fiber-optic cable.

6.1.2 Contractor shall not exceed the installation specifications of the fiber optic cable for the tension and bend radius. Purchaser will provide the cable specification upon request.

6.1.3 Contractor shall leave a 50' tail at each end of the fiber-optic cable run.

6.1.4 Purchaser will be responsible for splicing of fiber-optic cable.

6.2 INNERDUCT

6.2.1 Fiber-optic cable shall be installed in 1.5" HDPE annular ring corrugated orange duct when fiber is in cable trench or manholes and from the termination cabinet to the communications panel in the Electrical Equipment Enclosure (EEE).

6.2.2 Innerduct shall extend 1.5' into conduit when placed in manholes.

7. RESPONSIBILITIES

7.1 Contractor shall supply control cables meeting attached cable specifications, terminal fittings and all tools that may be needed for pulling and terminating of cable. The items include the unloading, handling and installation of all cable and terminal fittings used for power and control.

7.2 Contractor shall make all connections to apparatus as required herein or in other sections of the specifications, except as definitely stated or covered by another item.

[The remainder of this page has been intentionally left blank]

8. REVISION TABLE

Number	Date	By	Reviewed	Description
0	3/26/2019	BAH	KJB	Original Creation

9. TABLES

Table 1		
Conductor Size	Vertical Cable Support Spacing	
Conductor Size	Aluminum Conductor	Copper Conductor
1/0 AWG and Smaller	145	145
2/0 AWG thru 500 MCM	170	180
Larger than 500 MCM	245	242

MINNESOTA POWER

STANDARD EQUIPMENT SPECIFICATION

HIGH VOLTAGE INSTRUMENT TRANSFORMERS

SINGLE PHASE VOLTAGE TRANSFORMER

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Signature:____________________________________

Typed or Printed Name: Daniel Radloff
Date: June 22, 2023 License No.: 60050

Date	Prep	App
06/22/23	DJR	CKR

Standard Number

IT01PA

(Rev 4)

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14. REVISION TABLE 9

1. SCOPE

This standard covers outdoor, high-voltage inductive voltage transformers used as instrument transformers on Purchaser's transmission system. Manufacturer shall quote in strict conformance with these specifications. All exceptions to these specifications or any required standard shall be stated and explained in the submitted quotation.

2. REFERENCE STANDARDS

The voltage transformers shall be designed, manufactured, tested, and furnished according to the latest editions, revisions or amendments to the applicable standards of ANSI, NEMA and IEEE including IEEE Std. C57.13, latest revision. The equipment shall be manufactured to be in compliance with all applicable standards adopted pursuant to the Williams-Steiger Occupational Safety and Health Act of 1970. Any perceived conflicts between this specification and the outlined standards shall be brought to the attention of Purchaser to determine course of action.

The Supplement Specification, ***IT01PA-S1***, shall be considered.

3. TECHNICAL REQUIREMENTS

3.1 GENERAL

3.1.1 The voltage transformer shall be designed for the System Characteristics and Service Conditions outlined in ***Supplement Specification IT01PA-S1***.

3.1.2 Voltage transformers shall be of all new materials and of the latest manufacture and design. A rebuilt or used voltage transformer will not be acceptable.

3.2 ELECTRICAL CHARACTERISTICS

3.2.1 The voltage transformer electrical ratings shall be per ***Supplement Specification IT01PA-S1***.

3.2.2 The voltage transformer will be configured per ***Supplement Specification IT01PA-S1***.

3.2.3 The voltage transformer shall have a simultaneous accuracy on all windings.

3.2.4 The voltage transformer shall have two secondary windings. Each winding shall have a turns ratio and a tapped section per ***Table 1***.

3.2.5 Voltage transformer thermal rating shall be equally distributed on all windings.

3.3 PHYSICAL CHARACTERISTICS

3.3.1 The voltage transformer shall be designed per the Physical Characteristics outlined in ***Supplement Specification IT01PA-S1***.

3.3.2 Voltage transformers shall be mounted upright.

3.3.3 Voltage transformer shall be sky gray in color and conform to standard color designation ANSI #70.

3.3.4 All ferrous parts exposed to the weather and subject to corrosion shall be galvanized.

3.3.5 An oil level sight glass shall be provided, if oil is used.

3.3.6 The line terminals shall be furnished with a standard aluminum or tin plated bronze 4" NEMA 4-hole terminal pad.

3.3.7 A NEMA 2-hole pad shall be provided for Purchaser's grounding connection.

3.3.8 Lifting eyes or other lifting means shall be provided.

4. TESTS

4.1 Manufacturer shall provide design test reports for all applicable design tests described in NEMA and IEEE standards including IEEE Std. C57.13, latest revision.

4.2 The voltage transformer shall be subjected to all applicable production or routine tests described in NEMA and IEEE Standards including IEEE Std. C57.13, latest revision.

4.3 Purchaser reserves that right to witness factory testing. Manufacturer shall notify Purchaser a minimum of two (2) weeks prior to the start of testing.

4.4 One (1) digital copy of certified test reports shall be supplied for voltage transformer.

5. DOCUMENTATION

5.1 Information Required with Proposal

Manufacturer shall provide the following for each unique type of voltage transformer:

5.1.1 Data as indicated in ***Section 13***.

5.1.2 Outline drawings showing overall dimensions and relative location of all principal components

5.1.3 General description of type of materials used for principal components

5.2 Documents Required for Approval

Manufacturer shall provide one (1) electronic copy (AutoCAD 2018 or Adobe Acrobat Format) of the following for each unique type of voltage transformer:

5.2.1 Outline Drawings.

5.2.2 Nameplate Data

5.2.3 Schematic Diagrams

5.2.4 Instruction Manual

5.3 Documentation Required for Record

Approval drawings will not be retained for record purposes. Manufacturer shall provide one (1) electronic copy (AutoCAD 2018 or Adobe Acrobat Format) of the following for each voltage transformer to be used for Purchaser's final records:

5.3.1 Outline Drawings.

5.3.2 Nameplate Data

5.3.3 Instruction Manual

5.3.4 Installation Instructions

5.3.5 Safety Data Sheet for insulating medium

5.3.6 Certified Test Reports

One set of instruction books and drawings shall be shipped with the voltage transformer in a weatherproof envelope.

6. TOOLS

Manufacturer shall provide a list of any special tools required for installation, operation, or maintenance with pricing to be included as an adder on the proposal.

7. SPARE PARTS

Manufacturer shall provide a list of recommended spare parts with pricing to be included as an adder on the proposal.

8. SERVICE

The service of a competent installation technician may be required: to inspect the complete installation, to be responsible for the proper installation and operation of the voltage transformer, and to perform all tests that may be necessary. The cost of a competent installation technician shall be included as an adder on the proposal.

9. WARRANTY

Manufacturer warrants the equipment furnished is free from defects in material and workmanship and agrees to repair or replace any unit unsuitable for operation or which fails during normal and proper operation. The warranty shall be for a minimum of twelve (12) months from date of initial operation or eighteen (18) months from date of acceptance, whichever comes first.

10. PACKAGING AND DELIVERY

10.1 Manufacturer shall quote FOB site delivery.

10.2 Voltage transformer shall be securely strapped to a hardwood pallet(s) rated to support its weight.

10.3 Voltage transformer shall be protected from dirt, road grime, and flying debris during transit. Protection shall be shrink wrap, bubble wrap or other protective covering.

10.4 Voltage transformer shall be shipped by open flatbed truck only. There is no freight dock at delivery location.

10.5 Purchaser shall be notified a minimum of three working days before delivery.

10.6 Regular delivery hours are 8:00AM until 3:00PM, Monday thru Friday. Deliveries outside regular hours shall be coordinated with Purchaser and are subject to Purchaser approval.

10.7 Contact for Delivery: **See *Bid Documents***

11. ADDITIONAL INFORMATION

11.1 This standard shall be accompanied by ***Supplement Specification IT01PA-S1*** for Ratings and Technical Requirements completed by Purchaser, and ***Section 13***: Specific Information Required with Quotation for Manufacturer to complete.

11.2 Purchaser Proposed Schedule: ***See Bid Documents***

11.3 Contact for Technical Questions: **See *Bid Documents***

12. RATINGS AND TECHNICAL REQUIREMENTS

12.1 Purchaser Proposed Technical Requirements: ***See Supplement IT01PA-S1***

12.2 Table 1 and Table 2 Technical Information: ***See Next Page***

Table 1				
Nominal System Voltage (kV)	**Maximum Voltage (kV)**	**Rated Phase to Ground (kV)**	**Lightning Impulse Withstand Voltage (kV)**	**Turns Ratio**
46	48.3	27.6	250	400/240:1:1
69	72.5	40.25	350	600/350:1:1
115	121	69	550	1000/600:1:1
138	145	80.5	650	1200/700:1:1
161	170	92	750	1400/ 800:1:1
230	245	138	900	2000/1200:1:1

Table 2		
Nominal System Voltage (kV)	**Minimum Creep (In)**	**Minimum Phase to Ground Clearance (In)**
46	35	22
69	48	30
115	79	47
138	92	52.5
161	114	61.5
230	140	76

13. SPECIFIC INFORMATION REQUIRED WITH QUOTATION

Manufacturer shall submit the following completed form with their bid. One form shall be used for each unique item quoted. Failure to complete the form will result in a $1000 addition to the evaluated price.

13.1 General Information

a. Manufacturer		
b. Point of Manufacturer		
c. Point of Shipment		
d. Domestic Content		%
e. Delivery Date		Weeks ARO
f. Price per Unit (Tax NOT included)	$	
g. Warranty		
h. Type/Model Number		

13.2 Drawing Transmittal Time

a. Preliminary Drawings		Weeks ARO
b. Final Outline		Weeks ARO
c. Nameplate		Weeks ARO

13.3 Service Conditions

a. Ambient Temperature Rating		
b. Maximum Altitude		ft
c. Maximum Wind Speed		miles/hr
d. Maximum Ice Loading		inches
e. Maximum Seismic Performance		

13.4 Electrical Characteristics

a. Type		
b. Primary Voltage		kV
c. Secondary Voltage		V
d. Thermal Rating		
e. Rated Voltage Factor (30 sec)		
f. Power Frequency Withstand Voltage		kV (Wet)
g. Lightning Impulse Withstand Voltage		kV
h. RIV Test Voltage		kV
i. Accuracy (at specified burden)		
j. Burden		
k. Turns Ratio		

13.5 Physical Characteristics

a. Housing Type		
b. Height (bottom of base to top of unit)		in
c. Diameter (not including base)		in
d. Unit Weight (Approximate)		lbs
e. Creep		in
f. Phase to Ground Clearance		in
g. Maximum Primary Terminal Load		lbs
h. Insulating Medium		
i. Volume Insulating Medium		

13.6 Added for special tooling per Section 6

Tool or Device	Price
	$
	$
	$
	$

13.7 Adder for recommended spare parts per Section 7.

Spare Part	Price
	$
	$
	$

13.8 Adder for services per Section 8.

Service	Price
	$
	$
	$
	$

13.9 Exemption(s)

13.10 Required Documents Checklist

Manufacturer shall provide the following with quotation:

(i) Design Test Results	
(ii) Instruction Manual	
(iii) Outline Drawing	
(iv) Nameplate Ratings	

14. REVISION TABLE

Number	Date	By	Reviewed	Description
0	01/02/18	ARS		Original
1	02/16/18	ARS		Updated Section 13
2	02/09/21	DJS	RJB	Added PE Block, rearranged sections 12, 13 & 14 and added ratings and technical requirements to a supplement specification
3	10/15/21	PJK/BV	RJB	Updated Sections 3.2.2 and 3.2.4 per supplemental specification updates.
4	06/22/23	DJR		Updated charts to add 46 & 69 kV criteria

MINNESOTA POWER

STANDARD EQUIPMENT SPECIFICATION

HIGH VOLTAGE INSTRUMENT TRANSFORMERS

COUPLING CAPACTIOR VOLTAGE TRANSFORMER

hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Signature:___________________________________

Typed or Printed Name: Ryan Bishop
Date: October 15, 2021 License No.: 51308

Date	Prep	App
10/15/21	PJK/BV	RJB

Standard Number

IT02PA

(Rev 2)

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14. REVISION TABLE 10

1. SCOPE

This standard covers outdoor, high-voltage coupling capacitor voltage transformers (CCVT) used as instrument transformers on Purchaser's transmission system. Manufacturer shall quote in strict conformance with these specifications. All exceptions to these specifications or any required standard shall be stated and explained in the submitted quotation.

2. REFERENCE STANDARDS

The CCVTs shall be designed, manufactured, tested, and furnished according to the latest edition, revisions or amendments to the applicable standards of ANSI, NEMA and IEEE including:

2.1 IEEE Std. C57.13, latest revision.

2.2 The equipment shall be manufactured to be in compliance with all applicable standards adopted pursuant to the Williams-Steiger Occupational Safety and Health Act of 1970. Any perceived conflicts between this specification and the outlined standards shall be brought to the attention of Purchaser to determine course of action.

3. TECHNICAL REQUIREMENTS

3.1 GENERAL

3.1.1 The CCVT shall be designed for the System Characteristics and Service Conditions outlined in ***Supplement Specification IT02PA-S1.***

3.1.2 CCVTs shall be of all new materials and of the latest manufacture and design. A rebuilt or used CCVT will not be acceptable.

3.2 ELECTRICAL CHARACTERISTICS

3.2.1 The CCVT electrical ratings shall be per ***Supplement Specification IT02PA-S1.***

3.2.2 The CCVT will be configured per ***Supplement Specification IT02PA-S1.***

3.2.3 The CCVT shall have a simultaneous accuracy on all windings.

3.2.4 The CCVT shall have two secondary windings. Each winding shall have a turns ratio and a tapped section per ***Table 1.***

3.2.5 The CCVT thermal rating shall be equally distributed on all windings.

3.2.6 The CCVT shall have a passive ferroresonance circuit.

3.2.7 The CCVT shall be equipped with a condensation control heater capable of operating at 120 VAC but rated for 240 VAC.

3.2.8 The CCVT shall be supplied with standard carrier accessories including the following:

3.2.8.1 A drain coil.

3.2.8.2 An external, hook stick operable carrier ground switch.

3.2.8.3 A spark gap or surge diverter.

3.2.8.4 An insulated entrance bushing.

3.2.8.5 High frequency carrier connection enclosed within a junction box. External connections are unacceptable.

3.2.9 Voltage output, on loss of input, shall decrease to 5% of crest in 10 milliseconds.

3.2.10 An external hook stick operable potential transformer ground switch shall be provided.

3.3 PHYSICAL CHARACTERISTICS

3.3.1 The CCVT shall be designed per the Physical Characteristics outlined in ***Supplement Specification IT02PA-S1.***

3.3.2 CCVTs shall be mounted upright.

3.3.3 CCVTs shall be sky gray in color and conform to standard color designation ANSI #70.

3.3.4 All ferrous parts exposed to the weather and subject to corrosion shall be galvanized.

3.3.5 An oil level sight glass shall be provided, if oil is used.

3.3.6 The line terminals shall be furnished with a standard aluminum or tin plated bronze 4” NEMA 4-hole terminal pad.

3.3.7 A NEMA 2-hole pad shall be provided for Purchaser’s grounding connection.

3.3.8 The CCVT shall be designed to accept a line trap mounted vertically atop the device in conditions outlined in ***Supplement Specification IT02PA-S1.***

3.3.9 Lifting eyes or other lifting means shall be provided.

4. TESTS

4.1 Manufacturer shall provide design test reports for all applicable design tests described in NEMA and IEEE standards including IEEE Std. C57.13, latest revision.

4.2 The CCVT shall be subjected to all applicable production tests described in NEMA and IEEE standards including IEEE Std. C57.13, latest revision.

4.3 Purchaser reserves that right to witness factory testing. Manufacturer shall notify Purchaser a minimum of two (2) weeks prior to the start of testing.

4.4 One (1) digital copy of certified test reports shall be supplied for each CCVT.

5. DOCUMENTATION

5.1 Information Required with Proposal

Manufacturer shall provide the following for each unique type of CCVT:

5.1.1 Data as indicated in ***Section 13***.

5.1.2 Outline drawings showing overall dimensions and relative location of all principal components

5.1.3 General description of type of materials used for principal components

5.2 Documents Required for Approval

Manufacturer shall provide one (1) electronic copy (AutoCAD or Adobe Acrobat Format) of the following for each unique type of CCVT:

5.2.1 Outline Drawings.

5.2.2 Nameplate Data

5.2.3 Schematic Diagram

5.2.4 Instruction Manual

5.3 Documentation Required for Record

Approval drawings will not be retained for record purposes. Manufacturer shall provide one (1) electronic copy (AutoCAD 2007 or Adobe Acrobat Format) of the following for each CCVT to be used for Purchaser's final records:

5.3.1 Outline Drawings.

5.3.2 Nameplate Data

5.3.3 Schematic Diagram

5.3.4 Instruction Manual

5.3.5 Installation Instructions

5.3.6 Safety Data Sheet for Insulating Medium

5.3.7 Certified Test Reports

One set of instruction books and drawings shall be shipped with the CCVT in a weatherproof envelope.

6. TOOLS

Manufacturer shall provide a list of any special tools required for installation, operation, or maintenance with pricing to be included as an adder on the proposal.

7. SPARE PARTS

Manufacturer shall provide a list of recommended spare parts with pricing to be included as an adder on the proposal.

8. SERVICE

The service of a competent installation technician may be required: to inspect the complete installation, to be responsible for the proper installation and operation of the CCVT, and to perform all tests that may be necessary. The cost of a competent installation technician shall be included as an adder on the proposal.

9. WARRANTY

Manufacturer warrants the equipment furnished is free from defects in material and workmanship and agrees to repair or replace any unit unsuitable for operation or which fails during normal and proper operation. The warranty shall be for a minimum of twelve (12) months from date of initial operation or eighteen (18) months from date of acceptance, whichever comes first.

10. PACKAGING AND DELIVERY

10.1 Manufacturer shall quote FOB site delivery.

10.2 CCVT shall be securely strapped to a hardwood pallet(s) rated to support its weight.

10.3 CCVT shall be protected from dirt, road grime, and flying debris during transit. Protection shall be shrink wrap, bubble wrap or other protective covering.

10.4 CCVT shall be shipped by open flatbed truck only. There is no freight dock at delivery location.

10.5 Purchaser shall be notified a minimum of three working days before delivery.

10.6 Regular delivery hours are 8:00AM until 3:00PM, Monday thru Friday. Deliveries outside regular hours shall be coordinated with Purchaser and are subject to Purchaser approval.

10.7 Contact for Delivery: **See *Bid Documents***

11. ADDITIONAL INFORMATION

11.1 This standard shall be accompanied by the ***Supplement Specification IT02PA-S1:*** Ratings and Technical Requirements completed by Purchaser, and Section 13: Specific Information Required with Quotation for Manufacturer to complete.

11.2 Purchaser Proposed Schedule: ***See Supplement Specification IT02PA-S1 and Bid Documents***

11.3 Contact for Technical Questions: **See *Bid Documents***

12. RATINGS AND TECHNICAL REQUIREMENTS

12.1 Purchaser Proposed Technical Requirements: ***Supplement Specification IT02PA-S1***

12.2 Table 1 and Table 2 Technical Information: ***This Page***

Table 1

Nominal System Voltage (kV)	Maximum Voltage (kV)	Primary Voltage (kV)	Lightning Impulse Withstand Voltage (kV)	Turns Ratio	Capacitance (pF)
115	121	69	550	1000/600:1:1	~ 22500
138	145	80.5	650	1200/700:1:1	~18800
161	170	92	750	1400/ 800:1:1	~16200
230	245	138	900	2000/1200:1:1	~11250

Table 2

Maximum Voltage (kV)	Minimum Creep (In)	Minimum Phase to Ground Clearance (In)
121	79	47
145	92	52.5
170	114	61.5
245	140	76

13. SPECIFIC INFORMATION REQUIRED WITH QUOTATION

Manufacturer shall submit the following completed form with their bid. One form shall be used for each unique item quoted. Failure to complete the form will result in a $1000 addition to the evaluated price.

13.1 General Information

a. Manufacturer		
b. Point of Manufacturer		
c. Point of Shipment		
d. Domestic Content		%
e. Delivery Date		Weeks ARO
f. Price per Unit (Tax NOT included)	$	
g. Type/Model Number		

13.2 Drawing Transmittal Time

a. Preliminary Drawings		Weeks ARO
b. Final Outline		Weeks ARO
c. Nameplate		Weeks ARO

13.3 Service Conditions

a. Ambient Temperature Rating		
b. Maximum Altitude		ft
c. Maximum Wind Speed		miles/hr
d. Maximum Ice Loading		inches
e. Maximum Seismic Performance		

13.4 Electrical Characteristics

a. Type		
b. Primary Voltage		kV
c. Secondary Voltage		V
d. Thermal Rating		
e. Rated Voltage Factor (30 sec)		
f. Power Frequency Withstand Voltage		kV (Wet)
g. Lightning Impulse Withstand Voltage		kV
h. Switching Impulse Voltage		kV
i. RIV Test Voltage		kV
j. Accuracy (at specified burden)		
k. Burden		
l. Turns Ratio		
m. Capacitance		pF

13.5 Physical Characteristics

a. Housing Type		
b. Height (bottom of base to top of terminal)		in
c. Diameter (not including base)		in
d. Unit Weight (Approximate)		lb
e. Creep		in
f. Phase to Ground Clearance		in
g. Maximum Primary Terminal Load		lbs

h. Insulating Medium	
i. Volume Insulating Medium	

13.6 Added for special tooling per Section 6.

Tool or Device	Price
	$
	$
	$

13.7 Adder for recommended spare parts per Section 7.

Spare Part	Price
	$
	$
	$

13.8 Adder for services per Section 8.

Service	Price
	$
	$
	$

13.9 Exemption(s)

13.10 Required Documents Checklist

Manufacturer shall provide the following with quotation:

(i) Design Test Results	
(ii) Operations Manual	
(iii) Outline Drawing	
(iv) Nameplate Ratings	
(v) Schematic Diagram	

14. REVISION TABLE

Number	Date	By	Reviewed	Description
0	01/02/18	ARS		Original
1	09/24/18	ARS		Updated Section 14
2	10/15/21	PJK/BV	RJB	Reformat of existing 1T02PA Spec, changed section numbering, rearranged sections 12, 13 & 14. Section 3.2.2 and 3.2.4 updates.

MINNESOTA POWER

STANDARD EQUIPMENT SPECIFICATION

HIGH VOLTAGE INSTRUMENT TRANSFORMERS

SINGLE PHASE CURRENT TRANSFORMER

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Signature:___________________________________

Typed or Printed Name: Ryan Bishop
Date: October 15, 2021 License No.: 51308

Date	Prep	App
10/15/21	PJK/BV	RJB

Standard Number

IT04PA

(Rev 2)

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13. REVISION TABLE 8

1. SCOPE

This standard covers outdoor, free standing, high-voltage, current transformers used as instrument transformers on Purchaser's transmission system. Manufacturer shall quote in strict conformance with these specifications. All exceptions to these specifications or any required standard shall be stated and explained in the submitted quotation.

2. REFERENCE STANDARDS

The current transformers shall be designed, manufactured, tested, and furnished according to the latest editions, revisions or amendments to the applicable standards of ANSI, NEMA and IEEE including IEEE Std. C57.13, latest revision. The equipment shall be manufactured to be in compliance with all applicable standards adopted pursuant to the Williams-Steiger Occupational Safety and Health Act of 1970. Any perceived conflicts between this specification and the outlined standards shall be brought to the attention of Purchaser to determine course of action.

The Supplement Specification, ***IT04PA-S1***, shall be considered.

3. TECHNICAL REQUIREMENTS

3.1 GENERAL

3.1.1 The current transformer shall be designed for the System Characteristics and Service Conditions outlined in ***Supplement Specification IT04PA-S1***.

3.1.2 Current transformer shall be of all new materials and of the latest manufacture and design. A rebuilt or used current transformer will not be acceptable.

3.2 ELECTRICAL CHARACTERISTICS

3.2.1 The current transformer electrical ratings shall be per ***Supplement Specification IT04PA-S1.***

3.3 PHYSICAL CHARACTERISTICS

3.3.1 The current transformer shall be designed per the Physical Characteristics outlined in ***Supplement Specification IT04PA-S1.***

3.3.2 Current transformers shall be mounted upright.

3.3.3 Current transformer shall be sky gray in color and conform to standard color designation ANSI #70.

3.3.4 All ferrous parts exposed to the weather and subject to corrosion shall be galvanized.

3.3.5 An oil level sight glass shall be provided, if oil is used.

3.3.6 The line terminals shall be furnished with a standard aluminum or tin plated bronze 4" NEMA 4-hole terminal pad.

3.3.7 A NEMA 2-hole pad shall be provided for Owner's grounding connection.

3.3.8 Lifting eyes or other lifting means shall be provided.

4. TESTS

4.1 Manufacturer shall provide design test reports for all applicable design tests described in NEMA and IEEE standards including IEEE Std. C57.13, latest revision.

4.2 The current transformer shall be subjected to all applicable production or routine tests described in NEMA and IEEE Standards including IEEE Std. C57.13 latest revision.

4.3 Purchaser reserves that right to witness factory testing. Manufacturer shall notify Purchaser a minimum of two (2) weeks prior to the start of testing.

4.4 One (1) digital copy of certified test reports shall be supplied for each current transformer.

5. DOCUMENTATION

5.1 Information Required with Proposal

Manufacturer shall provide the following for each unique type of current transformer:

5.1.1 Data as indicated in ***Section 12.***

5.1.2 Typical ratio correction factor and phase angle curves for the standard burdens for which metering accuracy ratings are assigned

5.1.3 Outline drawings showing overall dimensions and relative location of all principal components

5.1.4 General description of type of materials used for principal components

5.2 Documents Required for Approval

Manufacturer shall provide one (1) electronic copy (AutoCAD 2018 or Adobe Acrobat Format) of the following for each unique type of current transformer:

5.2.1 Outline Drawings.

5.2.2 Nameplate Data

5.2.3 Schematic Diagrams

5.2.4 Excitation and Saturation Curves

5.2.5 Instruction Manual

5.3 Documentation Required for Record

Approval drawings will not be retained for record purposes. Manufacturer shall provide one (1) electronic copy (AutoCAD 2018 or Adobe Acrobat Format) of the following for each current transformer to be used for Purchaser's final records:

5.3.1 Outline Drawings.

5.3.2 Nameplate Data

5.3.3 Schematic Diagrams

5.3.4 Excitation and Saturation Curves

5.3.5 Instruction Manual

5.3.6 Installation Instructions

5.3.7 Safety Data Sheet for Insulating Medium

5.3.8 Certified Test Reports

One set of instruction books and drawings shall be shipped with the current transformer in a weatherproof envelope.

6. TOOLS

Manufacturer shall provide a list of any special tools required for installation, operation, or maintenance with pricing to be included as an adder on the proposal.

7. SPARE PARTS

Manufacturer shall provide a list of recommended spare parts with pricing to be included as an adder on the proposal.

8. SERVICE

The service of a competent installation technician may be required: to inspect the complete installation, to be responsible for the proper installation and operation of the current transformer, and to perform all tests that may be necessary. The cost of a competent installation technician shall be included as an adder on the proposal.

9. WARRANTY

Manufacturer warrants the equipment furnished is free from defects in material and workmanship and agrees to repair or replace any unit unsuitable for operation or which fails during normal and proper operation. The warranty shall be for a minimum of twelve (12) months from date of initial operation or eighteen (18) months from date of acceptance, whichever comes first.

10. PACKAGING AND DELIVERY

10.1 Manufacturer shall quote FOB site delivery.

10.2 Current transformer shall be securely strapped to a hardwood pallet(s) rated to support its weight.

10.3 Current transformer shall be protected from dirt, road grime, and flying debris during transit. Protection shall be shrink wrap, bubble wrap or other protective covering.

10.4 Current transformer shall be shipped by open flatbed truck only. There is no freight dock at delivery location.

10.5 Purchaser shall be notified a minimum of three working days before delivery.

10.6 Regular delivery hours are 8:00AM until 3:00PM, Monday thru Friday. Deliveries outside regular hours shall be coordinated with Purchaser and are subject to Purchaser approval.

10.7 Contact for Delivery: **See *Bid Documents.***

11. ADDITIONAL INFORMATION

Table 1

Nominal System Voltage (kV)	Maximum System Voltage (kV)	Lightning Impulse Withstand Voltage (kV)	Minimum Creep (inches)	Minimum Phase to Ground Clearance (inches)
115	121	550	79	47
230	245	900	146	76

11.1 This standard shall be accompanied by the Ratings and Technical Requirements, completed by Purchaser, in ***Supplement Specification IT04PA-S1*** and ***Section*** *Error! Reference source not found.*: Specific Information Required with Quotation for Manufacturer to complete.

11.2 Purchaser Proposed Schedule: ***See Bid Documents***

11.3 Contact for Technical Questions: **See *Bid Documents***

12. SPECIFIC INFORMATION REQUIRED WITH QUOTATION

Manufacturer shall submit the following completed form with their bid. One form shall be used for each item quoted. Failure to complete the form will result in a $1000 addition to the evaluated price.

12.1 General Information

a. Manufacturer		
b. Point of Manufacturer		
c. Point of Shipment		
d. Domestic Content		%
e. Delivery Date		Weeks ARO
f. Price per Unit (Tax NOT included)	$	
g. Type/Model Number		

12.2 Drawing Transmittal Time

a. Preliminary Drawings		Weeks ARO
b. Final Outline		Weeks ARO
c. Nameplate		Weeks ARO

12.3 Service Conditions

a. Ambient Temperature Rating		
b. Maximum Altitude		ft
c. Maximum Wind Speed		miles/hr
d. Maximum Ice Loading		inches
e. Maximum Seismic Performance		

12.4 Electrical Characteristics

f. Max. System Voltage		kV

g.	Power Frequency Withstand Voltage		kV (Wet)
h.	Lightning Impulse Withstand Voltage		kV
i.	Switching Impulse Voltage		kV
j.	RIV Test Voltage		kV
k.	Turns Ratio		
l.	Thermal Rating Factor (30°C avg. ambient)		
m.	Accuracy (at specified burden)		
n.	Burden		
o.	Short-time Mechanical Current		kA
p.	Short-time Thermal Current		kA

12.5 Physical Characteristics

a.	Housing Type		
b.	Height (bottom of base to top of terminal)		in
c.	Diameter (not including base)		in
d.	Unit Weight (Approximate)		lb
e.	Creep		in
f.	Phase to Ground Clearance		in
g.	Maximum Primary Terminal Load		lbs
h.	Insulating Medium		
i.	Volume Insulating Medium		

12.6 Added for special tooling per Section 6

Tool or Device	Price
	$

	$
	$
	$

12.7 Adder for recommended spare parts per Section 7.

Spare Part	Price
	$
	$
	$

12.8 Adder for services per Section 8.

Service	Price
	$
	$
	$

12.9 Exemption(s)

12.10 Required Documents Checklist

Manufacturer shall provide the following with quotation:

(i) Design Test Results	
(ii) Instruction Manual	
(iii) Outline Drawing	
(iv) Nameplate Ratings	

13. REVISION TABLE

Number	**Date**	**By**	**Reviewed**	**Description**
0	01/02/18	ARS	DJS	Original
1	02/15/21	DJS	RJB	Added PE Block, Standardized Ratio and Specification, rearranged sections 12,13, 14
2	10/15/21	PJK/BV	RJB	Updated Table 1 Maximum Voltage values.

MINNESOTA POWER

STANDARD EQUIPMENT SPECIFICATION

OUTDOOR MOTOR OPERATOR FOR

AIR BREAK SWITCHES

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Signature:___________________________________

Typed or Printed Name: Ryan Bishop
Date: October 26, 2021 License No.: 51308

Date	Prep	App
10/18/21	PJK/BV	RJB

Standard Number

MO01PA

(Rev 1)

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14. REVISION TABLE 10

1. SCOPE

This standard covers outdoor air break motor operators for switches used on Purchaser's transmission system. Manufacturer shall quote in strict conformance with these specifications. All exceptions to these specifications or any required standard shall be stated and explained in the submitted quotation.

2. REFERENCE STANDARDS

The motor operator shall be designed, manufactured, tested, and furnished according to the latest edition, revisions or amendments to the applicable standards of ANSI, NEMA and IEEE. The equipment shall be manufactured to be in compliance with all applicable standards adopted pursuant to the Williams-Steiger Occupational Safety and Health Act of 1970. Any perceived conflicts between this specification and the outlined standards shall be brought to the attention of Purchaser to determine course of action.

3. TECHNICAL REQUIREMENTS

3.1 GENERAL

3.1.1 The motor operator shall be designed for the System Characteristics and Service Conditions outlined in ***Supplement Specification MO01PA-S1***.

3.1.2 Motor operators shall be of all new materials and of the latest manufacture and design. Rebuilt or used motor operator will not be acceptable.

3.1.3 Manufacturer shall provide all provisions necessary to mount the motor operator and operating mechanism components to Purchaser supplied structural steel.

3.2 OPERATING MECHANISM

3.2.1 The operating mechanism shall be capable of manual operation upon complete power failure. Any special tooling required to manually operate the motor operator shall be supplied.

3.3 ELECTRICAL REQUIREMENTS

3.3.1 The motor operator electrical ratings shall be per ***Supplement Specification MO01PA-S1***.

3.3.2 Motor operator shall be able to turn the switch operator at a torque minimum per ***Supplement Specification MO01PA-S1***.

3.3.3 Individual mechanically interlocked open and close contactors.

3.3.4 Single pole 120 VAC circuit breaker protection for lighting and GFCI outlet.

3.3.5 Single pole 120VAC or double pole 240VAC circuit breaker for protection of heater circuits. Heater circuit voltage shall be per ***Supplement Specification MO01PA-S1.*** Manufacturer to confirm voltage in ***Section 13***.

3.3.6 Double pole 125 VDC circuit breakers for protection of control circuits.

3.4 CONTROL CIRCUIT AND WIRING

3.4.1 Local/remote selector switch

3.4.2 Motor operator shall be provided with open and close pushbuttons designed for outdoor operation.

3.4.3 Motor operator shall be provided with a stop pushbutton designed for outdoor operation.

3.4.4 Motor operator shall be provided with open and close indicators designed for outdoor operation.

3.4.5 All control wiring shall be a minimum of 14 AWG SIS wire, terminated on suitable terminal blocks in the mechanism housing.

3.4.6 AC terminal blocks shall be able to accommodate Purchaser's 6 AWG power cable.

3.4.7 A minimum of ten (10) spare auxiliary switches shall be furnished in addition to those required for the motor operator control circuit. The auxiliary switches shall be located in the motor operator control cabinet and located above the de-coupler to reflect the switch status at all times.

3.4.8 Operating mechanism limit switches shall be provided to prevent operation of the closing coil and motor contactor during abnormal or incomplete operation of the operating mechanism.

3.4.9 Trip circuit current shall be greater than 2 amps and not exceed 10 amps.

3.5 ACCESSORIES

3.5.1 The interior of the housing shall have a functional 120 VAC light mounted inside.

3.5.2 The interior of the housing shall have a functional 120 VAC, 20A, GFCI outlet inside.

3.5.3 Two (2) space heaters, designed for operation on 120 VAC or 240 VAC single phase (per ***Supplement Specification MO01PA-S1***), shall be provided. The heaters shall be low surface temperature or operable at half voltage. One heater shall be continuously energized for condensation control. The second heater shall be thermostatically operated. Manufacturer shall size heaters to provide condensation control and ensure operation at an exterior ambient temperature outlined in ***Supplement Specification MO01PA-S1***.

3.5.4 The construction of the control cabinet and any other housing or compartment for control or operation shall be designed for operation per ***Supplement Specification MO01PA-S1***. If necessary, Manufacturer shall filter, vent, insulate, and/or heat these compartments. Manufacturer shall test and supply information from such tests to indicate proper operation.

3.6 PHYSICAL/MECHANICAL REQUIREMENTS

3.6.1 The motor operator shall be designed per the Physical Characteristics outlined in ***Supplement Specification MO01PA-S1***.

3.6.2 All motor operator components shall be sky gray in color and conform to standard color designation ANSI #70.

3.6.3 Interphase linkage shall be of the torsional type or an acceptable substitute. All interphase connections and mounting hardware shall be supplied for single gang throw operation. All interphase connecting pipe fittings shall have piercing screws. All interphase connecting pipe shall have means of preventing water retention inside pipe by way of weep holes, open ends or combination thereof.

3.6.4 The motor operator linkage shall over-toggle into the fully open or fully closed positions and shall have adjustable mechanical stops for both the open and closed positions.

3.6.5 Operating mechanisms shall effect a smooth, thoroughly controlled movement throughout the entire opening and closing cycle and all rods, shafts, pipe linkages, connectors, operating levels, supports, and fittings shall show no noticeable deflection. Cable connections in lieu of rigid interphase rods are not acceptable.

3.6.6 A means shall be provided on each motor operator for taking up loose motion in each part of the mechanism and for adjusting the travel of each blade independently. The design of the mechanism shall be such that the main blades are positively toggled when in the fully open or fully closed position.

3.6.7 The manual operator shall be easily turned by a person of average strength without need for extension pipes or levers (35 lbs. for a worm gear operator and 60 lbs. for a swing handle operator).

3.6.8 The motor operator rod shall be supplied with an open/close indicator to identify current position of motor operator.

3.6.9 A swing handle or gear operator accessible for operation at ground level shall be provided.

3.6.10 There shall be provisions for padlocking the operator in both the open and closed positions.

3.6.11 An appropriately sized, flexible ground jumper shall be provided for the operating handle.

3.6.12 The motor operator shall have maintenance free removable door.

3.6.13 The motor operator shall have an internal de-coupler.

3.6.14 A viewing window shall be provided on the front door to allow a confirmation of decoupling position.

4. TESTS

4.1 Manufacturer shall provide design test reports for all applicable design tests described in NEMA and IEEE standards.

4.2 Motor operators shall be subjected to all applicable production tests described in NEMA and IEEE standards. Manufacturer shall provide a list of factory tests performed to verify proper mechanical or electrical operation of the motor operators.

4.3 Purchaser reserves that right to witness factory testing. Manufacturer shall notify Purchaser a minimum of two (2) weeks prior to the start of testing.

4.4 One (1) digital copy of certified test reports shall be supplied for each motor operator.

5. DOCUMENTATION

5.1 Information Required with Proposal

Manufacturer shall provide the following for each unique type of motor operator:

5.1.1 Data as indicated in ***Section 13***.

5.1.2 Outline drawings showing overall dimensions and relative location of all principal components

5.1.3 General description of type of materials used for principal components

5.2 Documents Required for Approval

Manufacturer shall provide one (1) electronic copy (AutoCAD or Adobe Acrobat Format) of the following for each unique type of motor operator:

5.2.1 Outline drawings

5.2.2 Wiring drawings

5.2.3 Nameplate Drawing

5.2.4 Instruction Manual

5.3 Documentation Required for Record

Approval drawings will not be retained for record purposes. Manufacturer shall provide one (1) electronic copy (AutoCAD 2007 or Adobe Acrobat Format) of the following for each motor operator to be used for Purchaser's final records:

5.3.1 Outline drawings

5.3.2 Wiring drawings

5.3.3 Nameplate Drawing

5.3.4 Instruction Manual

5.3.5 Installation Instructions

5.3.6 Certified Test Reports

One set of instruction books and drawings shall be shipped with the Motor operator in a weatherproof envelope.

6. TOOLS

Manufacturer shall provide a list of any special tools required for installation, operation, or maintenance with pricing to be included as an adder on the proposal.

7. SPARE PARTS

Manufacturer shall provide a list of recommended spare parts with pricing to be included as an adder on the proposal.

8. SERVICE

The service of a competent installation technician may be required: to inspect the complete installation, to be responsible for the proper installation and operation of the motor operator, and to perform all tests that may be necessary. All quotations must include the cost of a competent installation technician as an adder on the proposal.

9. WARRANTY

Manufacturer warrants the equipment furnished is free from defects in material and workmanship and agrees to repair or replace any unit unsuitable for operation or which fails during normal and proper operation. The warranty shall be for a minimum of twelve (12) months from date of initial operation or eighteen (18) months from date of acceptance, whichever comes first.

10. PACKAGING AND DELIVERY

10.1 Manufacturer shall quote FOB site delivery. ***See Bid Documents*** for delivery location.

10.2 All motor operator components shall be securely strapped to a hardwood pallet(s) rated to support its weight.

10.3 All motor operator components shall be protected from dirt, road grime, and flying debris during transit. Protection shall be shrink wrap, bubble wrap or other protective covering.

10.4 Motor operator shall be shipped by open flatbed truck only. There is no freight dock at delivery location.

10.5 Purchaser shall be notified a minimum of three working days before delivery.

10.6 Regular delivery hours are 8:00AM until 3:00PM, Monday thru Friday. Deliveries outside regular hours shall be coordinated with Purchaser and are subject to Purchaser approval.

10.7 Contact for Delivery: ***See Bid Documents***

11. <u>ADDITIONAL INFORMATION</u>

11.1 This standard shall be accompanied by the ***Supplement Specification MO01PA-S1***: Ratings and Technical Requirements completed by Purchaser, and ***Section 13***: Specific Information Required with Quotation for Manufacturer to complete.

11.1 Purchaser Proposed Schedule: ***See Supplement Specification MO01PA-S1 and Bid Documents***

11.2 Contact for Technical Questions: ***See Bid Documents***

12. <u>RATINGS AND TECHNICAL REQUIREMENTS</u>

12.1 Purchaser Proposed Technical Requirements: ***Supplement Specification CB01PA-S1***

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13. SPECIFIC INFORMATION REQUIRED WITH QUOTATION

Manufacturer shall submit the following completed form with their bid. **One form shall be used for each unique item quoted.** Failure to complete the form will result in a $1000 addition to the evaluated price.

13.1 General Information

a. Line Item/Description/Label		
b. Manufacturer		
c. Point of Manufacturer		
d. Domestic Content		%
e. Delivery Date		Weeks ARO
f. Price per Unit (Tax NOT included)	$	
g. Warranty		Months Post Delivery
		Months Post Install
h. Type/Model Number		

13.2 Documentation Transmittal Time

a. Preliminary Drawings		Weeks ARO
b. Wiring Diagram		Weeks ARO
c. Final Outline		Weeks ARO
d. Name Plate		Weeks ARO

13.3 Service Conditions

a. Ambient Temperature Rating		
b. Maximum Altitude		ft
c. Maximum Wind Speed		miles/hr
d. Maximum Ice Loading		inches

e. Maximum Seismic Performance	

13.4 Electrical Characteristics

a. Motor Running Range		Volts
b. Heater Circuit Voltage		V

13.5 Physical Characteristics

a. 6 Second Operating Time Torque		lb.-in
b. 10 Second Operating Time Torque		lb.-in
c. Direction to Open (Clockwise, CCW)		
d. Degrees of Full Operation		deg.
e. Operator Pipe Size		IPS
f. Height		in
g. Width		in
h. Depth		in
i. Shipping Height		in
j. Unit Weight (Approximate)		lbs

13.6 Applicable Factory Testing

13.7 Added for special tooling per Section 6

Tool or Device	Price
	$
	$
	$
	$

13.8 Adder for recommended spare parts per Section 7.

Spare Part	Price
	$
	$
	$

13.9 Adder for services per Section 8.

Service	Price
	$
	$
	$
	$

13.10 Exemption(s)

13.11 Required Documents Checklist

Manufacturer shall provide the following with quotation:

(i) Design Test Results	
(ii) Instruction Manual	
(iii) Outline Drawing	
(iv) Nameplate Ratings	

14. REVISION TABLE

Number	Date	By	Reviewed	Description
0	01/06/20	DJR		Original
1	10/18/21	PJK/BV	RJB	Created MO01PA-S1 Supplemental Spec and Changed section numbering, rearranged & updated sections 12, 13 & 14. Revised 3.3.5 to allow 120VAC heater, added wiring drawings to submittals

MINNESOTA POWER

STANDARD EQUIPMENT SPECIFICATION

STATION CLASS SURGE ARRESTERS

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Signature:___________________________________

Typed or Printed Name: Ryan Bishop
Date: October 15, 2021 License No.: 51308

Date	Prep	App
10/15/21	PJK/BV	RJB

Standard Number

SA01PA

(Rev 3)

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14. REVISION TABLE 10

1. SCOPE

This standard covers outdoor, high-voltage, station class surge arresters used within Purchaser's transmission substations. Manufacturer shall quote in strict conformance with these specifications. All exceptions to these specifications or any required standard shall be stated and explained in the submitted quotation.

2. REFERENCE STANDARDS

The surge arresters shall be designed, manufactured, tested, and furnished according to the latest edition, revisions or amendments to the applicable standards of ANSI, NEMA and IEEE including:

2.1 IEEE Std. C62.11-2012.

2.2 The equipment shall be manufactured to be in compliance with all applicable standards adopted pursuant to the Williams-Steiger Occupational Safety and Health Act of 1970. Any perceived conflicts between this specification and the outlined standards shall be brought to the attention of Purchaser to determine course of action.

3. TECHNICAL REQUIREMENTS

3.1 GENERAL

3.1.1 The surge arresters shall be designed for the System Characteristics and Service Conditions outlined in ***Supplement Specification SA01PA-S1***.

3.1.2 Surge arresters shall be of all new materials and of the latest manufacture and design. A rebuilt or used surge arrester will not be acceptable.

3.2 ELECTRICAL CHARACTERISTICS

3.2.1 The surge arrester electrical ratings shall be per ***Supplement Specification SA01PA-S1***.

3.2.2 The line terminals shall be furnished with a standard aluminum or tin-plated bronze 4" NEMA 4-hole terminal pad.

3.2.3 Corona mitigation shall be furnished for nominal system voltages above 230kV.

3.2.4 A NEMA two-hole bolted bronze, stainless or galvanized steel terminal shall be provided to attach Purchaser's 4/0 copper to ground. Single bolt terminals are not acceptable.

3.2.5 The arrester shall meet the requirements for a discharge Voltage-Current wave shape of 8x20 microsecond at various crest impulse values of current. The maximum impulse discharge voltages shall be per ***Table 1***.

3.2.6 The arrester shall meet the requirements for a discharge Volt-Time curve for a wave shape of .5 microsecond equivalent front-of-wave at various crest impulse values of current. The maximum front-of-wave discharge voltages shall be per ***Table 1***.

3.2.7 The arrester shall meet the requirements for a discharge Volt-Time characteristics for a wave shape of .45 microsecond switching surge (classifying current) at various crest impulse values of current. The maximum switching surge discharge voltages shall be per ***Table 1***.

3.3 PHYSICAL CHARACTERISTICS

3.3.1 The surge arrester shall be designed per the Physical Characteristics outlined in ***Supplement Specification SA01PA-S1***.

3.3.2 Surge arresters shall be capable of being mounted upright or underhung, per ***Supplement Specification SA01PA-S1***.

3.3.3 Surge arrester base shall be provided with three (3) mounting slots uniformly spaced on a 10" diameter bolt circle.

3.3.4 Surge arrester shall be sky gray in color and conform to standard color designation ANSI #70.

3.3.5 All ferrous parts exposed to the weather and subject to corrosion shall be galvanized.

3.3.6 Each arrester unit shall have a means for relieving internal pressure in the event of arrester failure.

3.3.7 In addition to the nameplate for the complete arrester stack, a nameplate for each unit of the stack shall be integrally attached to the respective unit.

4. TESTS

4.1 Manufacturer shall provide design test reports for all applicable design tests described in NEMA and IEEE standards including IEEE Std. C62.11-2012.

4.2 The surge arrester shall be subjected to all applicable production tests described in NEMA and IEEE standards including IEEE Std. C62.11-2012.

4.3 Purchaser reserves that right to witness factory testing. Manufacturer shall notify Purchaser a minimum of two (2) weeks prior to the start of testing.

4.4 One (1) digital copy of certified test reports shall be supplied for each surge arrester.

5. DOCUMENTATION

5.1 Information Required with Proposal

Manufacturer shall provide the following for each unique type of surge arrester:

5.1.1 Data as indicated in ***Section 13***.

5.1.2 Outline drawings showing overall dimensions and relative location of all principal components

5.1.3 General description of type of materials used for principal components

5.2 Documents Required for Approval

Manufacturer shall provide one (1) electronic copy (AutoCAD or Adobe Acrobat Format) of the following for each unique type of surge arrester:

5.2.1 Outline Drawings

5.2.2 Nameplate Drawing

5.2.3 Instruction Manual

5.3 Documentation Required for Record

Approval drawings will not be retained for record purposes. Manufacturer shall provide one (1) electronic copy (AutoCAD 2007 or Adobe Acrobat Format) of the following for each surge arrester to be used for Purchaser's final records:

5.3.1 Outline Drawings.

5.3.2 Nameplate Drawing

5.3.3 Instruction Manual

5.3.4 Installation Instructions

5.3.5 Certified Test Reports

One set of instruction books and drawings shall be shipped with the surge arrester in a weatherproof envelope.

6. TOOLS

Manufacturer shall provide a list of any special tools required for installation, operation, or maintenance with pricing to be included as an adder on the proposal.

7. SPARE PARTS

Manufacturer shall provide a list of recommended spare parts with pricing to be included as an adder on the proposal.

8. SERVICE

The service of a competent installation technician may be required: to inspect the complete installation, to be responsible for the proper installation and operation of the surge arrester, and to perform all tests that may be necessary. The cost of a competent installation technician shall be included as an adder on the proposal.

9. WARRANTY

Manufacturer warrants the equipment furnished is free from defects in material and workmanship and agrees to repair or replace any unit unsuitable for operation or which fails during normal and proper operation. The warranty shall be for a minimum of twelve (12) months from date of initial operation or eighteen (18) months from date of acceptance, whichever comes first.

10. PACKAGING AND DELIVERY

10.1 Manufacturer shall quote FOB site delivery.

10.2 Surge arresters shall be securely strapped to a hardwood pallet(s) rated to support its weight.

10.3 Surge arrester shall be protected from dirt, road grime, and flying debris during transit. Protection shall be shrink wrap, bubble wrap or other protective covering.

10.4 Surge arrester shall be shipped by open flatbed truck only. There is no freight dock at delivery location.

10.5 Purchaser shall be notified a minimum of three working days before delivery day.

10.6 Regular delivery hours are 8:00AM until 3:00PM, Monday thru Friday. Deliveries outside regular hours shall be coordinated with Purchaser and are subject to Purchaser approval.

10.7 Contact for Delivery: **See *Bid Documents***.

11. ADDITIONAL INFORMATION

11.1 This standard shall be accompanied by the ***Supplement Specification SA01PA-S1***: Ratings and Technical Requirements completed by Purchaser, and Section 13: Specific Information Required with Quotation for Manufacturer to complete.

11.2 Purchaser Proposed Schedule: ***See Supplement Specification SA01PA-S1 and Bid Documents***

11.3 Contact for Technical Questions: **See *Bid Documents***

12. RATINGS AND TECHNICAL REQUIREMENTS

12.1 Purchaser Proposed Technical Requirements: ***Supplement Specification SA01PA-S1***

12.2 Table 1 and Table 2 Technical Information: ***See Next 2 Pages***

Table 1

Nominal System Voltage (kV)	System Maximum Operating Voltage (kV)	Arrester Voltage Rating (kV rms)	MCOV Rating (kV)	Maximum Switching Surge Discharge Voltage (kV)*	Maximum Front of Wave Discharge Voltage (kV)	Maximum Impulse 10kA Discharge Voltage (kV)	Maximum Impulse 15kA Discharge Voltage (kV)
13.8	15.5	18	15.3	48	64	58	-
23	25.8	24	19.5	66	87	79	-
34.5	38	36	29	87	116	105	-
46	48.3	48	39	109	145	132	-
115	121	108	84	240	318	289	-
138	145	120	98	284	376	342	-
161	169	132	106	328	434	395	-
230	242	192	152	393	521	474	-

* 500A for 15kV - 46kV and 1000A for 115kV - 230kV

Table 2

Nominal System Voltage (kV)	Minimum Creep (In)	Minimum Phase to Ground Live Parts (In)	Minimum Height (In)	Maximum Height (In)
13.8	11	7	10	24
23	17	10	14	30
34.5	26	13	15	36
46	35	17	18	48
115	79	42	47	70
138	92	50	52.5	75
161	114	58	61.5	80
230	146	71	76	95

13. SPECIFIC INFORMATION REQUIRED WITH QUOTATION

Manufacturer shall submit the following completed form with their bid. **One form shall be used for each unique item quoted.** Failure to complete the form will result in a $1000 addition to the evaluated price.

13.1 General Information

a. Line Item/Description/Label		
b. Manufacturer		
c. Point of Manufacturer		
d. Point of Shipment		
e. Domestic Content		%
f. Delivery Date		Weeks ARO
g. Price per Unit (Tax NOT included)	$	
h. Type/Model Number		

13.2 Drawing Transmittal Time

a. Preliminary Drawings		Weeks ARO
b. Final Outline		Weeks ARO
c. Name Plate		Weeks ARO

13.3 Service Conditions

a. Ambient Temperature Rating		
b. Maximum Altitude		ft.
c. Maximum Wind Speed		miles/hr.
d. Maximum Ice Loading		inches
e. Maximum Seismic Performance		

13.4 Electrical Characteristics

a. Class		
b. Design (MOV, etc)		
c. Duty-cycle Voltage		kV
d. Maximum Continuous Operating Voltage		kV
e. Duty-cycle Voltage		kV
f. Maximum Continuous Operating Voltage		kV
g. Switching Surge Discharge Voltage		kV
h. Front of Wave Discharge Voltage		kV
i. Impulse 10kA Discharge Voltage		kV
j. Pressure Relief Class (Symmetrical)		kA
k. Energy Capability		kJ/kV MCOV

13.5 Physical Characteristics

a. Height (bottom of base to top of terminal)		in
b. Diameter (not including base)		in
c. Unit Weight (Approximate)		lb.
d. Maximum Design Cantilever Load		ft-lbs
e. Housing Type		
f. Arrester Orientation (Upright, Underhung)		

13.6 Added for special tooling per Section 6

Tool or Device	Price
	$
	$
	$
	$

13.7 Adder for recommended spare parts per Section 7.

Spare Part	Price
	$
	$
	$
	$

13.8 Adder for services per Section 8.

Service	Price
	$
	$
	$

13.9 Exemption(s)

13.10 Required Documents Checklist

Manufacturer shall provide the following with quotation:

(i) Design Test Results	
(ii) Instruction Manual	
(iii) Outline Drawing	
(iv) Nameplate Ratings	

14. REVISION TABLE

Number	Date	By	Reviewed	Description
0	01/02/18	ARS		Original
1	01/16/18	ARS		Added 6.6kV to Table
2	01/17/20	DJS	KJB	Added PE Stamp, updated IEEE standard name, updated sections 3.2.4, 5.2.2, 5.3.2 and Table 2.
3	10/15/21	PJK/BV	RJB	Created SB01PA-S1 Supplemental Spec and Changed section numbering, rearranged sections 12, 13 & 14. Revised 3.3.2

MINNESOTA POWER

STANDARD SPECIFICATION TR01PA

TRANSFORMER INSULATING OIL

STANDARD SPECIFICATION

ISSUE NO.	DATE	PREPARED BY	REVIEWED BY	PAGES AFFECTED
Original	05/23/95	ROM		
Revision 1	11/10/16	PSS		Page 2

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the state of Minnesota.

Signature ______________________

Rev.

Typed or Printed Name ______________________

Date ____________ Reg. No. ____________

MINNESOTA POWER
STANDARD SPECIFICATION TR01PA
TRANSFORMER INSULATING OIL

The manufacturer shall quote in strict conformance with these specifications. All exceptions to these specifications or any required standard shall be stated and explained in the submitted quotation.

1.0 SPECIFICATIONS

1.01 Inhibited insulating oil for transformers, circuit breakers, etc., shall conform to these Standard Specifications, except where modified by specific requirements given in the Project Specifications. Acceptance of tests are primarily based on C57.106-2015.

1.02 Inhibited insulating oil is a suitable refined mineral oil to which an oxidation inhibitor has been added.

2.0 STANDARDS

2.01 The inhibited insulating oil shall be manufactured and tested in accordance with the requirements of the following Standards of the American Society for Testing Materials (ASTM):

2.01.1 D 88-94 Test for Saybolt Viscosity

2.01.2 D 92-02 Test for Flash and Fire Points by Cleveland Open Cup

2.01.3 D 97-02 Test for Pour Point

2.01.4 D 1816-97 Test for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes

2.01.5 D 878-65 Test for Inorganic Chlorides and Sulfates in Insulating Oils

2.01.6 D 923-97 Sampling Electrical Insulating Oils

2.01.7 D 924-99e1 Test for Power Factor and Dielectric Constant of Electrical Insulating Fluids

2.01.8 D 971-99a Test for Interfacial Tension of Oil Against Water by the Rim Method

2.01.9 D 974-02 Test for Neutralizing Number by Color-Indicator Titration

2.01.10 D 1250-56 Petroleum Measurement Tables

2.01.11 D 1275-96a Test Corrosive Sulfur in Electrical Insulating Oils

2.01.12 D 1500-98 Test for ASTM Color of Petroleum Products (ASTM Color Scale)

2.01.13 D 1533-00 Test for Water in Insulating Liquids (Karl Fischer Method)

2.01.14 D 2668-96 Standard test method for 2,6 ditertiary butyl para-cresol and 2,6 ditertiary butyl prenol in electrical insulating oil by infrared absorption.

2.02 All of the above Standards shall be those in effect on the date of the Contract.

3.0 PROPERTIES

3.01 Viscosity: The viscosity shall not exceed 65 seconds, Saybolt Universal, at 37.8°C. Test Method ASTM D 88.

3.02 Flash Point: The flash point shall be 146°C or higher. Test Method ASTM D 92.

3.03 Pour Point: The pour point shall be minus 40°C or lower. Test Method ASTM D 97.

3.04 Dielectric Strength: The dielectric strength shall be 30kV or higher. Test Method ASTM D 1816.3.05

3.05 Mineral Acids: The oil shall be free from mineral acids (Chlorides and Sulfates). Test Method ASTM D 878.

3.06 Power Factor: The power factor shall not exceed 0.5 percent at 100°C. Test Method ASTM D 924.

3.07 Neutralization Number: The neutralization number or amount of potassium hydroxide in milligrams to neutralize 1.0 gram of oil shall be less than 0.04. Test Method ASTM D 974.

3.08 Free and Corrosive Sulphur: The oil shall not contain free sulphur or corrosive sulphur compounds. Test Method ASTM D 1275. The appearance of the copper strip in this test shall be as defined under the noncorrosive classification in Table 1 of ASTM D 1275.

3.09 Color Number: The ASTM Color Number shall be not more than 0.5 as determined by use of an ASTM colorimeter as defined in Appendix A1 of ASTM 1500. Test Method ASTM D 1500.

3.10 Oxidation Stability shall be determined by ASTM D 2440. The oil shall meet the requirements for acidification and sludging for type II oil per ASTM D 3487.

3.11 Water Content: The water content of the insulating oil shall be less than 35 ppm. Test Method ASTM D 1533.

3.12 Interfacial Tension (IFT) shall not scale less than 40 dynes per centimeter as determined by ASTM test Designation D-971 before inhibitor is added. The test should be repeated after any inhibitor is added.

4.0 METHOD OF TESTING

4.01 The samples on which tests are made shall be obtained by ASTM D 923, Sampling Electrical Insulating Liquids.

4.02 Definitions and statements on the significance of the specified tests may be found in ASTM Methods D 117, Testing Electrical Insulating Oils.

5.0 DETERMINATION OF QUANTITIES

5.01 The normal temperature for measurement of oil delivered under this Specification shall be 60°F. The temperature of the oil shall be determined at the time of volume measurement.

5.02 The apparent quantity of oil shall be corrected to a 60°F basis in accordance with ASTM D 1250, Petroleum Measurement Tables.

6.0 SHIPMENT

6.01 Insulating oil shall be shipped in tank cars or steel drums, as specified. Each container shall be oil-tight and sealed to prevent the entrance of moisture and shall be marked with purchase order number and Contractor's name. Each drum which can be returned to the Contractor for credit shall be marked with a serial number, either by figures stamped in relief on the barrel or by figures stamped on a brass plate and the plate brazed to the barrel head. The figures shall be at least 0.5 inch high and preferably 1.0 inch or more high.

MINNESOTA POWER
STANDARD SPECIFICATION TR09PA

TRANSFORMERS 5000kVA to 50000kVA BASE RATED
TWO WINDING AND AUTOTRANSFORMERS

STANDARD SPECIFICATION

ISSUE NO.	DATE	PREPARED BY	REVIEWED BY	PAGES/SECTIONS
Original				
Revision 1	12/03/08	ROM	ROM	4.01.10
Revision 2	5/23/12	RPS	RPS	Various
Revision 3	11/25/12	RPS	RPS	3.08, Added 3.09, 3.19 h.
Revision 4	5/08/13	RJB	RJB	4.01.6
Revision 5	12/04/13	ARH	RJB	Various
Revision 6	06/05/14	RJB	RJB	Various
Revision 7	08/26/15	RJB	RJB	Various
Revision 8	12/09/15	RJB	RJB	3.17
Revision 9	02/17/16	RJB	ARS	8.0, 4.09
Revision 10	11/19/19	DJS	RJB	9.03.9, 3.14, 3.18
Revision 11	6/14/2021	RJB	RJB	Various
Revision 12	07/1/2022	CKR	RJB	3.11.1
Revision 13	07/27/2022	CKR	RJB	4.02.6
Revision 14	12/27/2022	CKR	DJR	4.01.10

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the state of Minnesota.

Signature ____________________.

Rev.

Typed or Printed Name ____________________.

Date ________. Reg. No. ________.

MINNESOTA POWER
STANDARD SPECIFICATION TR09PA

TRANSFORMERS 5000kVA to 50000kVA BASE RATED
TWO WINDING AND AUTOTRANSFORMERS

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MINNESOTA POWER
STANDARD SPECIFICATION TR09PA
TRANSFORMERS 5000kVA to 60000kVA BASE RATED
TWO WINDING AND AUTOTRANSFORMERS

1.0 APPLICATION

This specification outlines the requirements for an outdoor, oil filled power transformer, two winding, transmission step down/step up, or autotransformer winding type transformer to be installed at a Minnesota Power Substation.

1.01 Standards

The transformer shall be designed, manufactured and tested in accordance with latest applicable ANSI, IEEE and NEMA standards, except as otherwise required by this specification. If any of the requirements of this specification are in conflict with these standards, the manufacturer shall notify Minnesota Power.

1.02 Bidders Exceptions

Any exceptions to this specification shall be clearly stated by the vendor. The vendor shall acknowledge receipt of any addenda.

2.0 DESCRIPTION

2.01 See Minnesota Power Specification TR23PA Appendix 2A for a complete description of the transformer windings, voltage class, rated current, basic insulation level, nominal voltage and frequency, rated output and cooling class.

3.0 ELECTRICAL REQUIREMENTS

3.01 See Minnesota Power Specification TR23PA Appendix 2A for the test insulation requirements. It is preferred to have an insulation design that does not include non-linear devices such as varistors. The Company reserves the right to reject the use of non-linear devices and shall approve their use in advance of the completion of the design. If approved, all non-linear devices shall be shown on the nameplate and be located in the main tank so they are accessible.

3.02 Impedance

The impedance between windings shall be as indicated on Minnesota Power Specification TR23PA Appendix 2A. For dual voltage transformers, impedance shall be listed for both voltage configurations.

3.03 Tap Voltage Ratings (No Load Operation)

The following taps, full capacity shall be provided as indicated in Minnesota Power Specification TR23PA Appendix 2A. For dual voltage transformers, taps shall be listed for both voltage configurations.

The following reduced capacity taps shall be provided as indicated in Minnesota Power Specification TR23PA Appendix 2A.

3.04 Angular Displacement

The angular displacement shall be: ANSI Standard

3.05 Transformer Loading

All components shall be designed for continuous operation at the rated load, and to be loaded as allowed by the latest IEEE overload guide. Ancillary devices, including load tap changers, de-energized tap changers, leads and bushings, shall be sized so that the design of the windings and cooling shall be the limitation to overload.

Transformer shall be capable of carrying rated load continuously without exceeding an average winding temperature rise of 65°C above a maximum 40°C ambient and an average ambient (for any 24-hour period) not exceeding 30°C, and in addition shall be capable of satisfactory operation under daily overloads and short-time overloads, in accordance with ANSI standards C57.91, latest revision.

Temperatures for overload conditions 3.05.01 and 3.05.02 listed below are as follows:

Ambient Temperature: 40°C
Maximum top oil temperature: 110°C
Maximum hottest spot conductor temperature: 130°C

3.05.01 Transformers above 100 MVA maximum nameplate rating require overloading within the following limits:

a. All windings except tertiary 130% of maximum N. P. rating.
b. Duration of load: 6 hours
c. Steady-state load prior to overload: 100 % of maximum N. P. rating

3.05.02 Transformers below 100MVA maximum nameplate rating require overloading within the following limits:

a. All windings except tertiary 125% of maximum N. P. rating.
b. Duration of load: 30 minutes
c. Steady-state load prior to overload: 100% of maximum N. P. rating.

3.05.3 Simultaneous Loading

The maximum simultaneous loading in the windings without exceeding ANSI Standard temperature rise limitations under each cooling condition shall be as specified in Minnesota Power specification TR23PA Appendix 2A.

3.06 Parallel Operation

The Transformer shall be suitable for parallel operation at rated voltage and on taps of like turns ratio when specified in Minnesota Power Specification TR23PA Appendix 2A.

3.07 Regulation

Provide calculated values of voltage regulation and phase regulation for the following expected loading conditions: See Minnesota Power Specification TR23PA Appendix 2A.

3.08 Short Circuit Withstand Capability

The transformer under this specification will be designed to meet the Short Circuit characteristics defined in ANSI C57.12.00, latest revision.

The transformer shall be capable of withstanding without damage the stresses caused by three-phase, phase-to-phase, or single or double phase-to-ground short circuits limited only by the transformer impedance on the external terminals of any winding, with rated voltage maintained across the terminals of the other winding(s).

When present, the tertiary shall be designed to be self protected for a three phase fault on the TV bushings. Available fault current at the Y bushing shall be limited to less than 20kA, rms, symmetrical three phase and phase-to-phase.

Values of system impedance to be used in calculating fault current magnitudes other than those indicated in ANSI/IEEE or described above are specified in Minnesota Power specification TR23PA Appendix 2A.

3.09 Overexcitation Capabilities

3.09.1 110% continuous at full load.

3.09.2 125% for 30 seconds at no load with the initial winding temperature stabilized at 65°C average winding temperature rise.

3.09.3 The core hot spot temperature shall be calculated for excitation conditions of 100% voltage and full load, 110% voltage and full load, and 115% voltage and no load. The maximum allowed core hot spot temperature is 130°C with an ambient temperature of 30°C for the worst case excitation condition listed above. The manufacturer shall be prepared to state the methodology of calculation and the means by which the calculations have been verified.

3.10 Exciting Current and Loss Guarantees

Performance data shall be guaranteed by the seller as in Section 3.09.1 and 3.09.2.

3.10.1 Excitation Current and Losses

The manufacturer shall provide excitation current and losses at rated voltage and 110% voltage and base MVA. This, in addition to excitation and losses at voltage tap positions.

3.10.2 The losses are both the no load loss in watts and the total loss in watts.

3.10.3 The manufacturer shall provide excitation current and losses at 100% rated voltage and base MVA at no load tap set at 0% and LTC or NLTC set at 0%. The losses shall include both no load and total losses.

The manufacturer shall supply calculated, exciting current, no load losses and total losses.

3.11 Operating Temperatures and Cooling

3.11.1 Ambient Temperature

The transformer shall be capable of operating at the specified loading and temperature rises and under no load conditions when installed in the conditions as specified in TR23PA Appendix 2A.

3.11.2 The transformer shall be capable of being energized at -20°F. Vendor shall confirm the lowest temperature at which the transformer can be energized.

3.12 Surge Arresters

Metal oxide type surge arresters and mounting bracket for each shall be furnished adjacent to the associated bushing of terminals H1, 2, 3, X1, 2, 3, Y1, 2, 3, and N (when specified). The surge arresters shall be ABB type POLIM-S or Hubbell type EVP.

All hardware and conductor for connecting arresters to bushings shall be provided and sized to carry the full rating of the transformer continuously. Also provide electrical ground connections using Cu bus bar minimum of ¼" by 2" between arrester ground terminals and ground pads at the base of transformer tank.

The anticipated need for or proposed use of internal arrester resistors or other nonlinear device for any reason shall be described in the proposal, and indicated on the nameplate.

3.13 Bushings

3.12.1 All bushings shall be oil filled and shall meet the requirements of ANSI C57.12.00 and C76.1, latest revisions, for bushings interchangeable between transformers and oil circuit breakers.

3.12.2 Bushings shall be sky gray in color, ANSI 70.

3.12.3 Bushings shall meet the insulation levels and BIL levels required in Section 3.01. The bushing shall be as indicated in Minnesota Power Specification TR23PA Appendix 2B.

3.12.4 All bushings shall be equipped with power factor testing taps.

3.12.5 The bushings shall be of a draw through lead type to facilitate installation, when feasible.

3.12.6 The bushings shall be supplied with stud to Nema 4 hole pad fittings suitable for full current rating.

3.14 Bushing Current Transformers

The transformer shall be furnished with multi-ratio bushing current transformers as indicated in Minnesota Power Specification TR23PA Appendix 2B,

Those indicated above are in addition to those required for the LTC operation or temperature detection.

CTs shall be of the five lead distributed winding type with all tap leads brought out to General Electric type EB-27, or equal, shorting type terminal blocks in the control cabinet. One extra terminal shall be provided on each shorting-terminal block for the purpose of grounding CT secondaries when changing taps. All CT secondaries shall be shorted to ground prior to shipment.

The current transformers shall be in accordance with ANSI C57.13, latest revision.

3.15 No Load Tap Changer

An externally manually operated no load tap changer shall be provided with padlockable provisions.

The Dial plate shall clearly indicate position number.

For three phase transformers, there shall be one external operating mechanism that will change the tap positions in all three phases.

The tap changer(s) shall be mounted under oil with self-cleaning stationary and movable contacts sized to carry the full rated current at each position.

The drive shaft shall have adequate universal joints, bearings and oil seals for smooth operation.

The tap changer contacts shall be silver plated and shall not be required to be operated routinely as part of maintenance.

Tap changer shall be located and arranged to provide for inspection and maintenance without untanking. The covers shall be welded construction.

Tap voltages shall be provided as specified in TR23PA Appendix 2A. Transformers specified as dual voltages shall list the voltage taps for both voltage connections on the nameplate. This information shall be included in the bid documents.

3.16 Load Tap Changing

A load tap changing (LTC) switch shall be provided when specified in TR23PA Appendix 2A. The load tap changing equipment shall provide +/-10% regulation of the nominal voltage with 33 steps. One tap position shall be at exactly zero net voltage regulation at no-load. The regulating or tap changing winding shall be fully distributed.

The load tap changing equipment shall be designed for remote and local electrical and manual non-automatic control. Provisions shall be made of manually moving the tap changer for adjustment and test. Also provide for remote and local tap position indication. Remote tap position indication shall be provided by binary coded decimal (BCD). An additional remote tap position status shall be provided for neutral position indication.

The LTC compartment shall be located separate from the main tank to prevent oil contamination in the main tank, and designed to permit full vacuum. Provide an alternate for an oil filtration system. This heavy duty filtration system shall have replaceable filters. Manufacturer shall indicate design and model provided. There shall be no oil or gas connection between the LTC compartment and the main tank.

Provisions of the above paragraph may be waived if a resistance based LTC is provided.

Positive continuous control of the LTC shall be provided. Once a tap changing operation has been initiated, the operation shall be continuous until the tap change is completed.

An operation counter shall be provided to record the number of tap changes. A white indicating lamp shall be provided to indicate when LTC is in the neutral or zero phase shift position.

The LTC shall be sized and applied in a manner that will provide extended contact life and low maintenance. The current carrying contacts shall have a minimum life of 500,000 operations.

A tap position indication for SCADA remote shall be provided. The signal shall be -1, 0, +1 milliampere from lowest position to highest position.

The transformer LTC shall be controlled with the following: Reinhausen Tapcon Controller or Beckwith M2001B tap changer control, Beckwith M5329 LTC backup control, and a Beckwith 2067 adapter. The vendor shall furnish and install the unit LTC control. The vendor shall propose a performance test to demonstrate the proper functioning of LTC and controller.

Automatic control shall have inputs from a source of line to ground voltage external to the transformer and from a current transformer located internally on bushing X2. The current transformer secondary current shall be compatible with the LTC control.

A means of disabling the automatic control shall be provided by bringing the input to the raise/lower contactors out to terminal blocks and inserting a jumper.

The LTC contacts shall be silver plated and shall not be required to operate periodically as part of maintenance if LTC is out of service for extended periods.

A sudden pressure relay shall be provided in the LTC tank per Minnesota Power specification TR23PA Appendix 8 and 9.

3.17 Dual Voltage Transformer Connection

Transformers specified as dual voltages shall have the variable connections made on a terminal board. The use of switches for this connection are specifically prohibited.

The terminal board shall be easily accessible and not require entry into the transformer tank for access. The board should be adequately electrically insulated and require minimal draining of transformer oil to change connections.

The board shall be clearly marked for each terminal and voltage connection. Similar markings shall be denoted on the transformer nameplate.

The proposed design or method of the variable voltage connections shall be included in the submitted bid documents. Number of units, years in service, and any warranty or in service issues shall be listed for the proposed design.

3.18 Control Cabinet

A control cabinet housing the electrical control devices and terminal blocks shall be provided with a hinged gasketed door(s) and a gasketed removable plate in the bottom which can be drilled for conduits. Door shall have provisions for padlocking. Cabinet shall be NEMA 3R (dust-tight, rain-tight and weather-resistant). The interior of the cabinet shall be painted gloss white enamel.

Ventilation and heaters thermostatically controlled shall be provided to prevent condensation. Heaters to be located to prevent damage to control cables or other devices. A separate 2PST fused switch shall be provided for each heater circuit. Also provide a 120 volt, 20 amp duplex grounded receptacle outlet with built-in ground fault circuit interrupter and a 100 watt lamp receptacle with toggle switch and a door operated switch.

Control cabinet shall contain terminal blocks for terminating all auxiliary equipment wiring, including cooling equipment control, LTC control, all alarm and relay contacts and all current transformer secondary leads. All wire shall be 600 volt flame retardant, moisture proof in conduit. CT wiring and wiring to tripping circuits shall be #10 AWG; control wiring shall be #14 AWG; auxiliary relay wiring and indicating lights shall be #16 AWG.

All wiring shall be terminated with ring lugs on screw terminal blocks. CT ring lugs shall be insulated.

The control panel shall be dead front with all switches, circuit breakers, relays enclosed and no 240 volt circuits exposed. 240 volt terminals and devices should be located separate from CT terminals and 120 VAC or 125 VDC equipment.
AC terminal blocks shall be able to accommodate Purchaser’s 6 AWG power cable.

3.19 Auxiliary Power and Control Wiring

Auxiliary control power shall be 120/240, 1-phase, 3-wire.

Provide two auxiliary power supply systems: one for fan and/or pump power; one for lighting and 120V duplex receptacle.

Alternate when specified in Minnesota Power Specification TR23PA Appendix 2B.

3.20 Alarms and Monitors

All alarm and relay contacts shall be rated for use with purchaser's 125 volt DC system. Each alarm shall be wired independently to terminal blocks in the control cabinet. The following standard alarms and monitors shall be furnished when indicated in Minnesota Power Specification TR23PA Appendix 8:

a. Winding hot-spot dial type temperature indicator with contacts for controlling both stages of cooling and for alarm and tripping.

b. Liquid temperature dial type indicating device with adjustable alarm contacts so arranged to permit true temperature indication after alarm point is passed.

c. Magnetic liquid level gauge and alarm contact to close at the minimum safe operating level.

d. A cover mounted self resealing mechanical type pressure relief device with semaphore and alarm contacts on each compartment.

e. The oil pumps shall be equipped with flow indication with alarm contact to indicate low oil flow. (When necessary.)

f. Pressure alarms to indicate low pressure differential across a cooler which is in operation. (When necessary.)

g. Cooling equipment loss of power alarms with a 30 second time delay to avoid nuisance alarms.

h. A sudden fault pressure relay will trip a local lockout relay per Minnesota Power Specification TR23PA Appendix 9. The circuit shall contain a loss of power alarm.

i. Gas accumulator/detector relay with alarm and tripping contacts.

3.21 Loss Evaluation

The transformer losses and capital costs will be evaluated at the rates indicated in Minnesota Power Specification TR23PA Appendix 2A. If final tests determine load and/or no load losses exceed the guaranteed, the loss dollar/kilowatt values will be used to determine any price adjustment. Individual loss dollars will be combined to determine the price adjustment. No price adjustment will be applied if the total loss dollars are lower than guaranteed.

4.0 MECHANICAL REQUIREMENTS

4.01 Tank and Fittings

The main tank shall be of welded construction with welded joints as required for removal of top and necessary sections. Tank welds with oil on one side shall be welded inside and outside with continuous bead welds.

The tank shall be designed for vacuum filling in the field and for a positive pressure of at least 10 psig.

4.01.1 Manholes

Manholes shall be large enough to permit access to lower end of bushings, terminals, tap changer and accessories without removal of tank cover. Manholes shall allow removal of any current transformers mounted internally on bushings. Minimum manhole size shall be 18" in diameter.

Cover shall be designed to avoid any space which would allow gas accumulation and defeat a gas accumulator relay. Provisions and design shall be such that internally generated gases are directed to the gas accumulator relay.

4.01.2 Base

The base shall be designed such that it can be moved with rollers along the major transformer axis.

The manufacturer shall show centerlines for both the shipping center of gravity, and the assembled center of gravity on the outline drawing. Both centers of gravity shall be marked on all sides of the base of the transformer with a weld line and a label. The label shall be permanent and survive any environmental fading. A triangular notch cut in the baseplate signifying assembled center of gravity is preferred.

4.01.3 Handling

For moving and handling the transformers, the following appurtenances shall be provided:

a. Pulling eyes near base.

b. Lifting lugs for lifting assembled transformer tank plus oil.

c. Jacking bosses for raising assembled transformer, minimum height 17".

d. Lifting accessories for manhole covers.

4.01.4 Standard ANSI and NEMA ground pads shall be provided on the tank.

4.01.5 The tank shall be equipped with replaceable valving for cooling equipment and tank mounted mechanical relays.

4.01.6 A combination drain and lower filler valve shall be provided. This lower valve shall drain the oil to within one inch of the bottom of the tank. The size of the lower drain valve shall be 2-inch NPT, with a brass plug provided.

The lower valve shall have a built-in lower sampling valve, 3/8-inch, located between the main valve and brass plug. The sampling device shall be supplied with 5/16-inch x 32 male thread and supplied with cap.

Valves shall be suitable for vacuum filling. All valves shall have suitable packing silicone or otherwise to prevent leakage.

The upper filler valve shall be one-inch NPT with a brass plug and located near the top of the tank.

4.01.7 Tank mounted accessories

Self-resealing mechanical type pressure relief device shall be provided. This device shall be located above oil liquid level. The device shall be located on top of tank for conservator type units.

4.01.8 The transformer will be installed on a slab foundation.

4.01.9 Winding Hot Spot Well (Spare)

Provide a spare winding hot spot well with hot spot CT for future temperature monitoring.

4.01.10 Neutral Bushing Connection

A dedicated copper bus bar shall be run from the neutral bushing to the base of the transformer. The neutral bus bar shall be insulated with a minimum dielectric strength of 2kV. The minimum size of the copper bus bar is ¼" by 4".

4.02 Cooling and Heat Exchangers

4.02.1 Cooling class shall be ONAN/ONAF/ONAF, ONAN/ONAF/OFOF, or ONAN/ODAF/ODAF, as indicated in Minnesota Power Specification TR23PA Appendix 2A.

4.02.2 Cooling equipment shall be controlled from winding hot-spot temperature (necessary current transformers shall be in addition to all other current transformers specified). Each set shall include a dial-type temperature indicating relay; dial indicator design and mounting arrangement shall permit reading from ground level near the transformer.

4.02.3 Leads from the current transformers and heating coils used for winding temperature simulation shall be wired to suitable terminal blocks in the cooling equipment control compartment to permit complete calibration testing at ground level.

4.02.4 All radiators shall be removable. Manufacturer shall furnish suitable shutoff valves on the transformer side of the radiator mounting flanges. Top and bottom drain valves with plugs (minimum 1/2-inch) in the radiators, shall be provided to permit draining and removal of the radiators without draining oil from the transformer.

4.02.5 Oil pumps shall be located near foundation level; manufacturer shall furnish suitable valves on both sides of each pump and pipe tap with plug (minimum 1/2-inch) at the lowest point on the pump section between valves, to permit draining, or removal. If power supply to pumps is made through connectors which must also seal the oil system, suitable mechanical guards shall be furnished to prevent breakage of the connectors and resultant oil leakage.

4.02.6 Cooling fans shall be located only on the sides or bottom (not on the top) of the radiators to provide maintenance accessibility with adequate safety clearances from transformer live parts. Bottom mounted fans shall be adequately located to be unobstructed from snow when installed in the conditions as specified in TR23PA Appendix 2A

4.02.7 Cooling equipment requirements, their estimated ratings, and loadings shall be as follows:

a. Cooling medium will be air at 40°C maximum.

b. Cooling devices shall be separated into two completely separate groups.

c. Automatic control of fans and pumps shall be in two steps.

d. For triple rated transformers, control shall be actuated in each winding by winding temperatures to pick up three or four separate and isolated contacts.

4.02.8 Radiators shall be supplied with the hot dip galvanized exterior finish.

4.02.9 The radiators shall be designed to withstand full vacuum and up to 10 psig positive. The radiators shall be adequately braced to prevent any movement.

4.03 Oil Preservation System

4.03.1 Manufacturer shall state what type of oil preservation system is provided. If a nitrogen (or other inert gas) pressure system is provided, it shall be complete with the following:

a. Gas cylinder

b. Three stage pressure regulation

c. Pressure relief valves and alarm

d. Pressure vacuum gauge

- Pressure vacuum gauge shall be visible from ground level.
- Transformer shall be shipped with pressure vacuum gauge installed.

e. Alarms for low nitrogen cylinder gas pressure.

f. Alarms to indicate high and low gas pressure in transformer.

4.04 Manufacturer shall furnish the necessary quantity of insulating oil. The oil shall be supplied in tank trucks or in drums and barrels if a smaller quantity, (less than 15 barrels). The oil shall conform to Minnesota Power Specification TR01PA "Standard Specifications for Inhibited Insulating Oil".

4.05 Audible Sound Level

The predicted audible sound level shall be provided. The transformer shall be designed so mechanical features will not be in any resonance with naturally generated sound of transformer.

When specified in Minnesota Power Specification TR23PA Appendix 2A, an audible sound level evaluation shall be required. For the purposes of this evaluation, the sound level shall be measured on the "A" weighted scale in accordance with NEMA TR1.

If the normal sound level as measured previously exceeds this amount, an alternate quotation for acoustical treatment will be considered.

4.06 Painting and Cleaning

The tank accessories and tank interior and exterior shall be thoroughly cleaned. The interior shall be treated or painted white to maintain cleanliness. The exterior surfaces shall be primed and painted, with ASA70 gray, silicone base, alkyd enamel (Sherwin Williams) or equal, the prime and final coat on the exterior surfaces shall be oil resistant, moisture-proof, three mils dry film thickness. The top of the tank shall be treated such that its paint will give a non-skid surface.

4.07 Maintenance Accessibility

Gauges, including pressure vacuum (whenever possible), liquid level, liquid temperature, and winding hot spot temperature shall be located at an appropriate viewing height and in close proximity to each other.

Externally accessible grounding points shall be provided for the core. The ground connection shall be brought through the cover with bushings protected with an enclosure. If auxiliary transformers such as series transformers or preventive autotransformers are placed within the main tank, separate core grounds shall be brought out for each auxiliary transformer.

4.08 Safety Railings

Safety railings shall be provided (see TR23PA Appendix 5).

4.09 Safety Rescue Brackets

Safety Rescue Brackets (Manufacturer DBI-SALA-UCL - Part Number 8517266) shall be provided. Brackets shall be located at each mahole on the transformer cover per TR23PA Appendix 6 and installed per manufacturer’s instructions.

5.0 NAMEPLATE

A diagram nameplate shall be provided and located at eye level above the base of the transformer. The information furnished shall include nameplates for all current transformers and be in accordance with nameplate "C" of ANSI C57.12.00, Section 5.12, latest revision.

6.0 TESTS

The results of all tests shall be reported in the manufacturers certified test reports. All tests shall be in accordance with the latest revision of ANSI C57.12.90, latest revision and referenced standards therein, unless specifically listed otherwise.

For dual voltage transformers, all tests shall be performed for both voltage configurations. Testing will be performed with transformer configured for 161/115kV operation first and reconfigured and tested for 138/115kV second. After successful completion of all tests, transformer will be shipped in 138/115kV configuration. Vendor may propose an option to waive redundant testing. The option must clearly state which tests do not require testing in both voltage configurations and documentation why the testing is not required. Tests not requiring redudant testing shall be done in most limiting case.

6.01 The manufacturer shall perform all routine tests as listed in ANSI C57.12.90, latest revision.

6.02 A series of dielectric tests shall be performed on all terminals which are brought out from the tank. Unless mentioned otherwise, terminals “H”, “X”, and “Y”, if present, are to be tested as such. The dielectric tests shall be in accordance with ANSI C57.12.14, latest revision.

6.02.1 Impulse tests shall be performed on terminals and windings indicated in Section 6.02. This shall include the "chopped wave" and "full wave" BIL value. The value shall be as listed in ANSI C57.12.14, latest revision.

6.02.1.1 Impulse tests shall be performed on both voltage configurations of the “H” winding.

6.02.2 The manufacturer shall perform a switching surge test. The value shall be in accordance with ANSI C57.12.14, latest revision.

6.03 Low frequency tests shall be performed. Both applied and induced potential tests shall be included as part of the low frequency tests.

6.03.1 Applied voltage tests shall be performed in accordance with ANSI C57.12.14, latest revision, when required.

6.03.2 The induced voltage test shall be performed in accordance with ANSI C57.12.14, latest revision. In addition to the voltage impressed during the induced voltage tests, an enhancement period shall be added. This enhancement shall be to 1.73 p.u. for approximately 7200 cycles, as close as practical to the start of the test.

6.03.3 Partial discharge measurements shall be made during the tests as outlined in 6.03.2 and in accordance with ANSI C57.12.14, latest revision.

The transformer shall be deemed to be acceptable from a partial discharge test standpoint if there is no sustained increase in partial discharge during the last 20 minutes of the test, the increase in partial discharge does not exceed 30μV, and the magnitude of the partial discharge does not exceed 300ρC and the RIV does not exceed 100μV.

6.04 Capacitance - dissipation or power factor tests shall be made. Capacitance - dissipation or power factor shall be measured at maximum allowable voltage up to 10kV AC. For two winding transformers the measurements are to be made on H to X, H to "Ground" and X to "Ground". The insulation resistance shall be measured at 2.5kV.

6.05 A test for unintentional core grounds shall be made prior to shipment.

6.06 Provide alternate pricing. Temperature rise tests shall be performed at the self cooled rating (ONAN) and at the maximum forced cooled rating in accordance with ANSI C57.12.90, latest revision.

6.07 Zero sequence impedances, at nominal rated voltage, at each tap position specified in TR23PA Appendix 2A.

6.08 Gas in Oil Testing shall be made after all dielectric tests, and Dissolved Gas Analysis shall be performed on the transformer oil before and after each test. The acceptance criteria for the DGA are as follows as a measurement of change in the gases before and after the specific test involved: hydrogen – 15ppm, methan – 5ppm, ethan – 2ppm, ethylene – 2ppm, acetylene – not detected, carbon monoxide – 25ppm, and carbon dioxide – 250ppm.

6.09 Manufacturer shall describe and perform test to determine tank and seal integrity. The tank shall withstand hot insulating oil under slight pressure, for a suitable time period without leaks.

6.10 CT Ratio tests are required for all provided current transformers

6.11 When LTC is present, resistance tests of all windings H, X, and Y. Test with the LTC on neutral, all DETC taps; with the DETC on the highest tap, test half the LTC taps (16R-1L).

6.12 Temperature guage alarm point testing will be performed by using a test thermal well to test the thermocouple, guages, and alarm and/or trip settings.

6.13 The manufacturer shall perform the following field tests once the transformer has been set in place.

6.13.1 DC Winding Resistance

6.13.2 Transformer Turns Ratio

6.13.3 Capacitance – disipation or power factor tests

7.0 SHIPMENT INSTRUCTIONS

The unit shall be shipped in the upright position and filled with dry air at 3 psig pressure. The insulating fluid shall be shipped via tank truck, (lesser volumes may be via drums or barrels). When possible the transformer shall be shipped oil filled.

The manufacturer shall provide two vertical and horizontal impact recorders for the shipment with capability for 60 days of recording. Each recorder shall be adequately attached. The vendor shall make provision that the recorders shall function throughout the duration of the shipment. The impact recorders shall receive an impact directly before being placed on the transformer with the impact visible on the recorder records. Impact recorder setting limits to be provided to Minnesota Power before offloading.

All exposed transformer terminals shall be grounded for shipment.

Dual voltage transformers shall be shipped in the 138/115kV configuration.

The transformer shall be wrapped to prevent road grime accumulation. In the case where it is unreasonable to have the transformer wrapped, it shall be cleaned by Manufacturer after it has been set on the pad.

See TR23PA Appendix 3 for delivery point and contacts.

8.0 DRAWINGS AND TEST REPORTS

8.01 Manufacturer shall furnish one (1) paper copy of applicable full size drawings and other information and one electronic copy (AutoCad 2012 and Adobe Acrobat format) of same from the following list. The paper copy shall be included in the transformer control cabinet when shipped. If all required information is not available at time of shipment, one (1) additional paper copy shall be sent once all required information is available. The electronic copy is to be provided to the engineer listed in Minnesota Power Specification TR23PA.

8.01.1 Assembled transformer outline drawing (including structural details of transformer base; center of gravity of installed unit and of unit prepared for shipment; and minimum dimensions and weight of unit prepared for shipment).

Control cabinet outline drawing including device locations, labels, and Bill of Material.

8.01.2 Nameplate drawing (including identification of type of winding construction and conductor material used in each winding) for the main unit and LTC as required. The nameplate drawing shall show the final tested impedance of the transformer. Nameplate shall contain a statement that the transformer has been designed for step-up and/or step-down operation.

8.01.3 Bushing outline and nameplate drawings and test reports. Drawings shall show test tap voltage ratio and voltage withstand capabilities.

8.01.4 Tap Changer Outline and Operation and Maintenance Manual, including drawings, Bill of Materials and description literature for tapchanger position indicator transducers.

8.01.5 Surge arrester outline drawings.

8.01.6 Terminal fitting drawings.

8.01.7 Schematic and wiring diagrams showing number, size, and power requirements of fans and pumps; fan and pump control; load tap changing equipment control; alarm and relay connections; and current transformer connections.

8.01.8 Test circuit diagram (including complete identification of all devices and terminal points), calibration curves, and complete factory test data.

8.01.9 Current transformer nameplate drawings, and current transformer characteristic curves showing ratio correction and secondary excitation for relaying accuracy CT's, and ratio and phase angle correction for metering accuracy CT's.

8.01.10 Complete lists of renewal parts for the transformer and all auxiliary equipment, including identification of each part by name and part number. Renewal parts list for LTC equipment shall be accompanied by detailed drawings and exploded views as required to facilitate complete maintenance by purchaser. Parts, lists and drawings shall not be merely typical, but rather shall relate specifically to the equipment covered by this specification.

8.01.11 Certified test reports, shall be sent as indicated in Minnesota Power Specification TR23PA Appendix 3, as soon as possible after manufacture. This shall include electronic copies of capacitance tests in Doble format.

8.01.12 Instruction Books

Manufacturer shall supply one (1) paper copy and one electronic copy (Adobe Acrobat format) of all necessary instruction booklets for installation, operation and maintenance of the transformer and associated devices. The paper copy shall be included in the transformer control cabinet when shipped. The electronic copy is to be provided to the engineer listed in Minnesota Power Specification TR23PA.

Instruction booklets shall include information of all transformer and auxiliary equipment i.e. bushings, arresters, LTC equipment, cooling equipment, transformer and instruments. Information shall include settings for fan and pump overload relays, pickup and/or dropout timing, etc.

8.01.13 Pictures of the core and coil assembly and pretanking must be provided to Minnesota Power as soon as possible during manufacturing.

9.0 INFORMATION TO BE FURNISHED WITH PROPOSAL

In addition to any information required elsewhere in the specification, the following information shall be provided with the proposal and will be used in the Minnesota Power evaluation:

9.01 Delivery; manufacturer shall state earliest delivery

9.02 Shipment point

9.03 Drawing and data submittal

The attached Minnesota Power Project Data Sheet Appendix 1A shall be completed and returned with the proposal. The proposal shall be deemed incomplete without Appendix 1A complete and attached. For dual voltage transformers, data shall be stated clearly and exclusively for each dual voltage winding connection.

Submit dates when the approval drawings listed can be furnished.

When a design review is required per Minnesota Power Specification TR23PA, submit dates when the design review is required to take place. Minnesota Power will not committ to material selection prior to the design review and only after resolution of all requests arising from the design review.

9.03.1 Outline drawing

9.03.2 Electrical data

9.03.3 Mechanical data

9.03.4 Oil type, quantity, and preservation system

9.03.5 Tap Changers: Both DETC and LTC, if applicable

9.03.6 Transformer weights and dimensions

9.03.7 Shipment:
List of items shipped separately

9.03.8 List of Manufacturers Tests

9.03.9 Spare Parts

The vendor shall provide pricing to furnish the following spare parts:

a. Spare H, X, Y, and Neutral bushings; cost per each.

b. One spare cooling fans and motors for same.

c. One spare cooling pump motors and impellers, if any.

d. Optional pricing for composite bushings.

9.04 Failure Rate

A transformer failure is defined as any difficulty requiring return of the transformer to a manufacturing or repair facility or a difficulty which requires a field repair of core and coil assembly.

$$\text{Annual Failure Rate} = \frac{\text{Total Failure Since 1/1/78}}{\text{Transformer Service Years Since 1/1/78}}$$

9.04.1 The manufacturer to supply the following data for units 50 MVA and above and 450kV BIL and greater:

All units shipped since 1/1/78
Transformer service years since 1/1/78
Number of failures

10.0 OTHER OPTIONS

10.01 Field Engineering Services

The manufacturer shall furnish an alternate to provide field engineering services. The representative shall be present for installation, testing and checkout to provide technical advice and inspection as required.

10.02 Installation

When specified, the manufacturer shall provide a separate proposal to install the transformer complete on-site. The installation shall include: receiving, moving, oil filling, installation of all equipment, testing and final checkout. The manufacturer shall specify the lifting distance assumed in the bid. If no lifting distance is provided, it is assumed there is no distance restriction for transformer offloading. Outriggers will not be allowed to be placed inside of oil containment basins under any circumstances.

Contractor shall conduct and provide lift planning services in accordance with Minnesota Power safety policies and all applicable regulations, including, but not limited to, State and Federal OSHA requirements.

Offloading with crane requires Supplier to provide a site-specific lift plan using a MN Power foundation plan or drawing as a background. A site visit is required by the Supplier or Supplier's representative prior to submittal of the lift plan. Item 1 is to be provided five (5) weeks prior to delivery. Items 2-4 are to be provided 48 hours prior to delivery.

1. Rigging plan and information
    a. Location of truck/trailer
    b. Location of crane
    c. Final outrigger locations
    d. Distance from center of crane to center of extended outrigger post
    e. Dimensions from center of crane to cetnerline of outriggers, sides, front and back
    f. Copy of crane load charts and note pages
2. Copy of Operator's NCCCO card
3. Copy of Annual 3rd Party Crane Inspection
4. Copy of insurance certificate

Offloading by jack and slide requires Supplier to provide a site-specific plan using a MN Power foundation plan or drawing as a background. The following information should be included with the plan, five (5) weeks prior to delivery. A site visit is required by the Supplier or Supplier's representative prior to submittal of the plan. If a crane is to be used to set equipment on the slide, the lift plan requirements also apply.

1. Location of truck/trailer
2. Location and orientation of equipment on trailer
3. Maximum height of equipment on:
    a. Trailer
    b. Rails
    c. Foundation
4. Cribbing and rail dimensions with description
5. Positioning of all equipment used for offload

Minnesota Power will provide all power wiring, grounding, control wiring necessary for the transformer. Minnesota Power will also provide all foundation work.

10.03 Warranty

Manufacturer shall state period of warranty and terms. The manufacturer shall indicate any extended warranty options and provide optional pricing for a five (5) year warranty. Minimum warranty shall be 24 months from date of energization.

All gaskets and welds shall be guaranteed to be leak free for five years. The manufacturer shall be responsible for repair of any leaks within the five-year period.

10.04 Apparatus in Service Requiring Repair

If, after the apparatus has been installed, it is discovered that it, or any part thereof is functioning but nonconforming and may require correction as herein elsewhere provided, Minnesota Power shall nevertheless have the right to use such apparatus until such time as it is convenient to Minnesota Power that such apparatus be removed from service for correction.

Purchaser's Identification
No.:
Date:

MINNESOTA POWER

STANDARD SPECIFICATION TR23PA

TRANSFORMER SPECIFICATION DATA SHEETS
TWO WINDING TRANSFORMERS 5000KVA TO 50000KVA BASE RATED,
AUTOTRANSFORMERS
AND
REMANUFACTURED TRANSFORMERS

ISSUE NO.	DATE	PREPARED BY	REVIEWED BY	PAGES AFFECTED
Original	02/17/15	RJB		
1	10/16/15	RJB	RJB	
2	11/13/15	RJB	RJB	Appendix 8
3	02/17/16	RJB	ARS	Appendix 6
4	11/19/19	DJS	RJB	Appendix 2A, 3.09
5	8/27/2021	RJB	RJB	Appendix 1A
6	7/1/2022	CKR	RJB	1.01-1.04
7	7/23/2022	CKR	RJB	1.05

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the state of Minnesota.

Signature ______________________.

Rev.

Typed or
Printed Name ______________________.

Date ________.________ Reg. No. ______.______

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APPENDIX 1A
TECHNICAL EVALUATION
VENDOR SUPPLIED INFORMATION
NEW UNITS ONLY

All manufacturers submitting a bid under this specification are required to answer the information listed below.

MANUFACTURER ______
SHIPMENT DATE ______
SHIPMENT ORIGIN ______
RECEIPT OF ADDENDA ______

DRAWINGS: (Drawing Transmittal Time in weeks)
- Outline Preliminary ______
- Base Loading ______
- Center of Gravity ______
- Wiring Diagram ______

ELECTRICAL DATA:
- Cooling Class ______
- Phase ______
- Core/Form ______
- Flux Density @ 1.0 pu V______T @ 1.1 pu V________T

WINDING:	H	X	Y	N
Conductor				
Nominal Sys Volts				
Transf Connection				
Rated Wind Volts				
Current Density A/mm^2 @ Top Rating				
MVA Ratings				
Self Cooled				
Second Stage				
Third Stage				
65C Top Rating				
VOLTAGE TAPS: (H/X)				
(Off Load) kV				
(Off Load) kV				
(Off Load) kV (Nominal Tap)				
(Off Load) kV				
(Off Load) kV				
Other				
INSULATION LEVELS:				
BIL				

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TECHNICAL EVALUATION
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TEST LEVEL WINDINGS				
Applied Potential kV				
Induced Potential kV				
Partial Discharge uV				
	H	X	Y	N
Chopped Wave Crest kV				
Full Wave kV				
SWITCHING SURGE:				
Crest kV				
BUSHINGS:				
Manufacturer				
Catalog No/Type				
BUSHING INSULATION CLASS:				
BIL (kV)				
RATED CURRENT AMPS:				

EFFICIENCY:	
Full Load	
50%	
IMPEDANCE:	
H-X: DETC Max:	
DETC Neutral	
DETC Min:	
H-Y	
X-Y	
For LTC Units at tap positions	
16 raise (H-X)	
8 raise (H-X)	
Neutral (H-X)	
8 lower (H-X)	
16 lower (H-X)	
REGULATION %:	Base MVA
pf unity	
Pf .8%	

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RESISTANCE:
H Winding __________
X Winding __________

LOSSES:
NO LOAD LOSS kW
100% V __________
110% V __________

LOAD LOSSES kW
100% V __________
110% V __________

Auxiliary losses kW:
First Stage __________
Second Stage __________

ZERO SEQUENCE IMPEDANCE:
Excitation Current 100% V __________
Excitation Current 110% V __________

SHORT CIRCUIT CAPACITY:
Standard __________

MECHANICAL DATA:

ASSEMBLED PHYSICAL SIZE:

Assembled Transformer		Transformer Base
Height __________	Skids or flat base	__________
Width __________	Width	__________
Depth __________	Depth	__________

HEIGHT OVER BUSHINGS:
Height above “H” __________
Height Over Tank __________

WEIGHT (In Pounds):
Core & Coils __________ Shipping Weight ____________
Oil __________
Tank &Fittings __________
Untanking Weight __________

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TRANSFORMER OIL:
- Oil Type ________
- Gallons ________
- Oil Preservation System ________

COOLERS (when furnished)
- Surface Area ________
- Number of Tubes ________

COOLER OR FAN CONTROL
- 1st Stage Cooling Set @ °C ________
- 2nd Stage Cooling Set @ °C ________
- Alarm Stage Set @ °C ________
- Trip Contact @ °C ________

	Capacity (cfm or Gpm)	Number	Type	Size (hp)	Speed (rpm)	Locked Rotor (amp)
FANS						
PUMPS						

SOUND LEVELS:
- Level (dBA):
- Base Rating ________
- 1st Stage Cooling ________
- 2nd Stage Cooling ________

CURRENT TRANSFORMERS:
- Manufacturer: ________
- Ratio & Accuracy ________

SURGE ARRESTERS:
- Manufacturer: ________

SEPARATELY SHIPPED ITEMS: ________

SHIPPED OIL FILLED: ________

EXCEPTIONS: ________

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APPENDIX 2A
ELECTRICAL DATA
TRANSFORMERS 5000kVA to 50000KVA BASE RATED
(MINNESOTA POWER SUPPLIED INFORMATION)
NEW UNITS ONLY

(Contractor to fill in data below)

1.0 APPLICATION

1.01 Site Name:

1.02 Site Location:
1.03 Approximate Elevation:

1.04 Temperature Requirements

Maximum Daily Average:
Minimum Recorded:
Maximum Recorded:

1.05 Average Snow Fall:

2.0 DESCRIPTION

2.01 Type:
Cooling Class:
Rated Output:
Voltage Class:
Rated Full Load Current:
Connections:

2.01.1 _______ Provide an alternate for the following:

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APPENDIX 2A
ELECTRICAL DATA
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3.0 ELECTRICAL REQUIREMENTS

3.01 Insulation Requirements

	Full Wave	Chopped Wave	Switching Surge
H, primary	________kV BIL	________kV	________kV
X, secondary	________kV BIL	________kV	________kV
Y, tertiary	________kV BIL	________kV	________kV
N, Neutral bushing	________kV BIL	________kV	________kV

3.02 Impedance

The impedance between windings shall be :

	Winding	%Z	**@ Base MVA**
H-X	________	________	
H-Y	________	________	
X-Y	________	________	

3.03 Tap Voltage Ratings (No Load Operation)

The following taps, full capacity shall be provided as indicated below:

H winding ________, ________, ________, ________, ________, ________, ________, kV
X winding ________, ________, ________, ________, ________, ________, ________, kV
Y winding ________, ________, ________, ________, ________, ________, ________, kV

_______ The following reduced capacity taps shall be provided as indicated below:

Capacity ________,________, ________, ________, ________, ________, ________, MVA
H winding ________, ________, ________, ________, ________, ________, ________, kV
X winding ________, ________, ________, ________, ________, ________, ________, kV
Y winding ________, ________, ________, ________, ________, ________, ________, kV

3.04 Load Tap Changing

_______ Load Tap Changing is to be provided.

MINNESOTA POWER
STANDARD SPECIFICATION TR23PA
TRANSFORMER SPECIFICATION DATA SHEETS
TWO WINDING TRANSFORMERS 5000KVA TO 50000KVA BASE RATED,
AUTOTRANSFORMERS
AND
REMANUFACTURED TRANSFORMERS

APPENDIX 2A
ELECTRICAL DATA
TRANSFORMERS 5000kVA to 50000KVA BASE RATED
(MINNESOTA POWER SUPPLIED INFORMATION)
NEW UNITS ONLY

3.05 Transformer Loading

_______ Simultaneous Loading

The maximum simultaneous loading in the windings without exceeding ANSI Standard temperature rise limitations under each cooling condition shall be as follows when specified: The transformer should be designed for simultaneous loading provided the arithemetic sum of the XV and TV does not exceed the full rating of the transformer

Duty Cycle	Winding kV	Type of MVA	Pf	Type of Cooling	Temperature Rise by Resistance °C
Continuous	________	________	________	________	____________

3.06 Parallel Operation

N/A The Transformer shall be suitable for parallel operation at rated voltage and on taps of like turns ratio with the following units:

MVA	kV to kV	%Z	MFR	Serial No.
________	________	________	________________	_____

3.07 Short Circuit Withstand Capability

_______ Values of system impedance to be used in calculating faults current magnitudes are as follows:

HV Kv % impedance

LV kV, % impedance

_______ All impedances are on a ***100*** MVA base. The ratio of X_0 /X_1 equals has been used for both systems.

_______ The transformer shall be designed to meet ANSI C57.12.00.

_______ The transformer shall be designed for infinite bus

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NEW UNITS ONLY

3.08 Surge Arresters

_______ ***Station class*** ______ ***Intermediate class*** metal oxide type surge arresters and mounting bracket for each shall be furnished adjacent to the associated bushing of terminals. Arrester rating shall be ***84 kV*** line to ground maximum continuous operating voltage for H1, 2, 3, ***29 kv*** for X1, 2, 3, ***N/A*** kV for Y1, 2, 3 and ***N/A*** kV for N respectively.

3.09 Auxiliary Power and Control Wiring

_______ Provide auxiliary power supply to allow two separate sources to feed transformer loads. Purchaser will provide two full capacity 120/240 volt, 1-phase, 3-wire power supplies with a manual transfer switch between them to the control cabinet for cooler pumps, fans and LTC motor and control.

_______ Purchaser to provide two 120/240 volt, 3 wire single phase services. One for fan and/or pump power if present; one for auxiliary power.

_______ Minnesota Power Drawing CR10.05.121587 for typical power supply wiring is attached.

_______ Vendor shall provide two 3PDT manually operated power supply selector switches to permit connecting either or both cooler groups to either power supply.
Separate control transformers, if necessary, shall be provided, one for each cooler group.

The control relays and circuits shall be designed for ___________ **VDC.**

3.10 Loss Evaluation

_______ The transformer losses and capital costs will be evaluated at the following rate:

		A	B (alternate loss numbers If supplied)
3.19.1	No Load Losses ($/kW)	$ ___________	____________________
3.19.2	Load Losses ($/kW)	$ ___________	____________________
3.19.3	Capital Cost Factor	___________	____________________
3.19.4	Auxiliary Equipment power costs, all stages	___________	____________________

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APPENDIX 2A
ELECTRICAL DATA
TRANSFORMERS 5000kVA to 50000KVA BASE RATED
(MINNESOTA POWER SUPPLIED INFORMATION)
NEW UNITS ONLY

3.11 Audible Sound Level

_______ An audible sound level evaluation will be made. For the purposes of this evaluation, the sound level shall be measured on the "A" weighted scale in accordance with NEMA TR1. The transformer shall be designed to meet a dBA sound level at MVA.

_______ If the normal sound level as measured previously exceeds this amount, an alternate quotation for acoustical treatment will be considered.

_______ Provide an alternate for audible sound tests to be performed in accordance with ANSI C57.12.90, latest revision.

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APPENDIX 2B
ELECTRICAL DATA – BUSHINGS & CURRENT TRANSFORMERS
TRANSFORMERS 5000kVA to 50000KVA BASE RATED
(MINNESOTA POWER SUPPLIED INFORMATION)
NEW TRANSFORMERS ONLY

3.12 Bushings

3.12.1 All bushings shall be oil filled and shall meet the requirements of ANSI C57.12.00 and C76.1, latest revisions, for bushings interchangeable between transformers and oil circuit breakers.

3.12.2 Bushings shall be sky gray in color, ANSI 70.

3.12.3 Bushings shall meet the insulation levels and BIL levels required in Section 3.01, Insulation Requirements, unless noted otherwise below. Bushing ampacities to be sized to carry rated current. TV and Neutral bushings to be matching model numbers.

Bushings	H	X	Y	N
BIL Level	_______ kV	_______ kV	_______ kV	_______ kV
Continuous Current	_______ ampere	_______ ampere	_______ ampere	_______ ampere
Minimum Creep	_______ inches	_______ inches	_______ inches	_______ inches

3.12.4 All bushings shall be equipped with power factor testing taps.

3.12.5 The bushings shall be of a draw through lead type to facilitate installation, when feasible.

3.12.6 Current Transformers:

H winding position X ____, Y _____________, Z _____________

X winding position X ____________, Y _____________, Z ____________

Y winding position X ____________, Y _____________, Z ____________

N winding position X ____________, Y _____________, Z ____________

Accuracy _____C800_________, unless indicated otherwise

Rating Factor _____2.0_____, unless indicated otherwise

Does not include hot spot winding CT or other current transformers required for instruments on or in tank, including LTC.

3.12.7 Two external bushings for permanent installation for the internal delta, if present, for field test purposes shall be provided. Basic insulation level same as teriary winding.

3.12.8 Add a "spark plug" rated a minimum of 2.5kV for core ground tests, minimum current rating 50 amps. Add insulating cover.

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STANDARD SPECIFICATION TR23PA
TRANSFORMER SPECIFICATION DATA SHEETS
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REMANUFACTURED TRANSFORMERS

APPENDIX 3
DELIVERY AND CONTACTS
GENERAL ALL TRANSFORMERS
ALL TRANSFORMERS

Contact for Technical Questions: ____________________________________

Email: ____

Telephone: _________

Contact for Delivery: _____________________

Address: ____

Telephone: ____

Fax: ____

Email: ____

Delivery Point: __________________

____

____

Contact 48 Hours prior to delivery

Map Attached: ________ Y, ________ N

Delivery: FOB foundation on Site, Oil filled

Warrantee: 60 months after energization or 66 months after shipment

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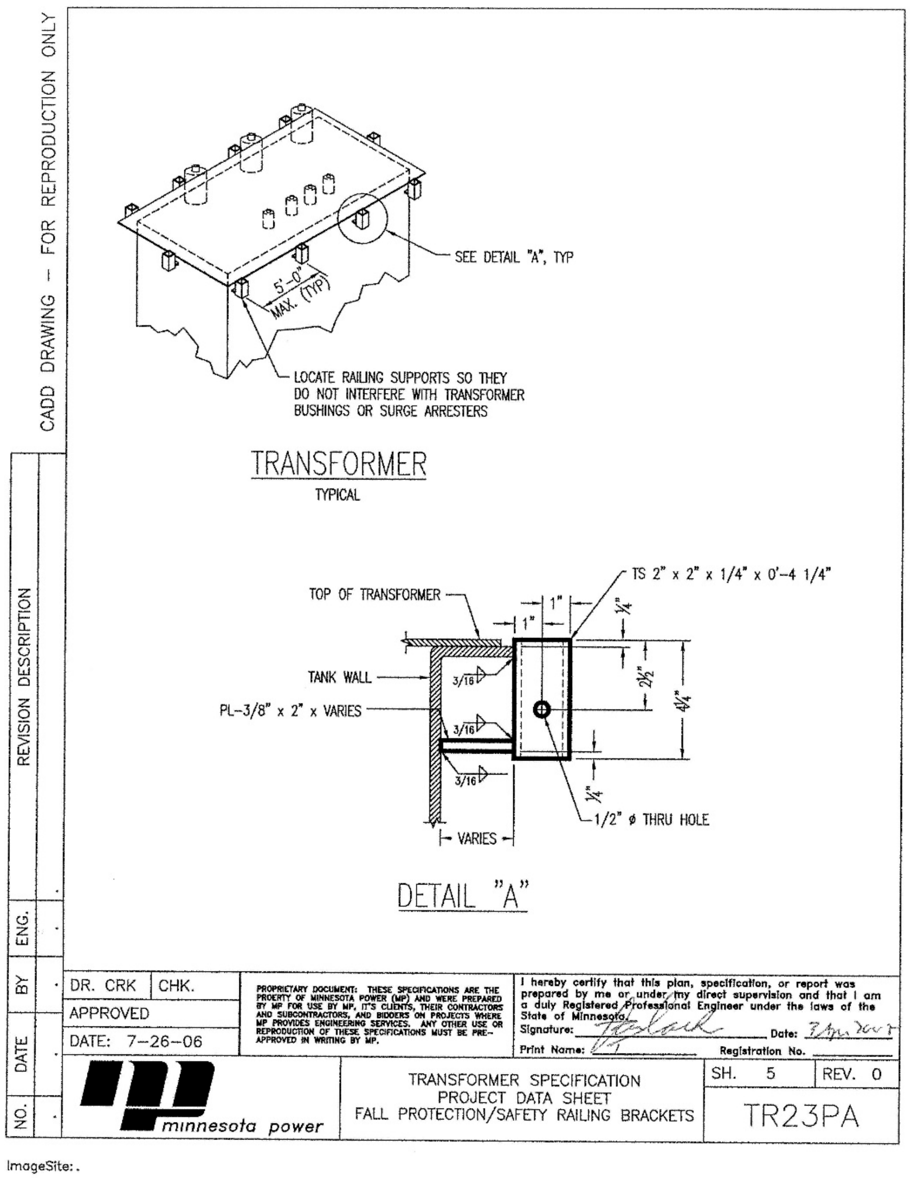
APPENDIX 5
SAFETY RAILINGS
GENERAL ALL TRANSFORMERS



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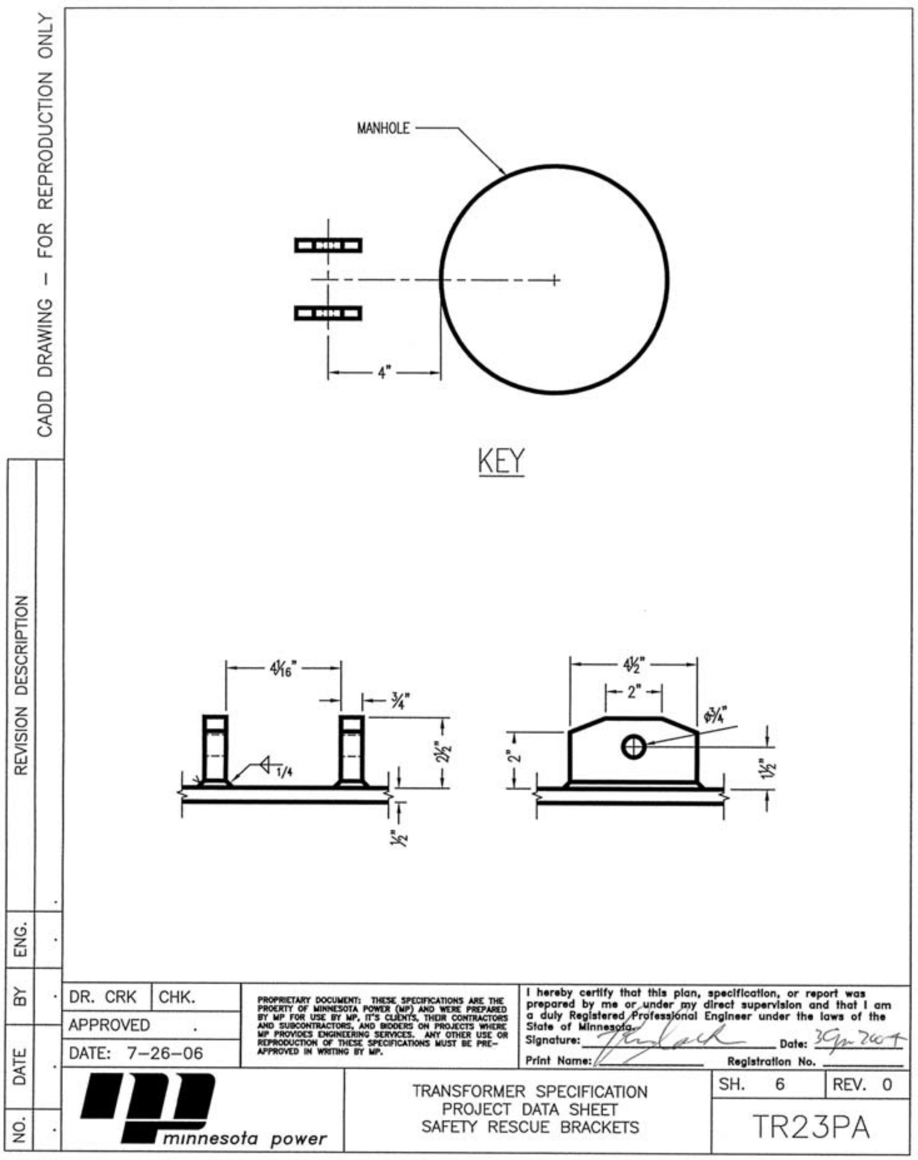
APPENDIX 6
SAFETY BRACKETS
<u>GENERAL ALL TRANSFORMERS</u>



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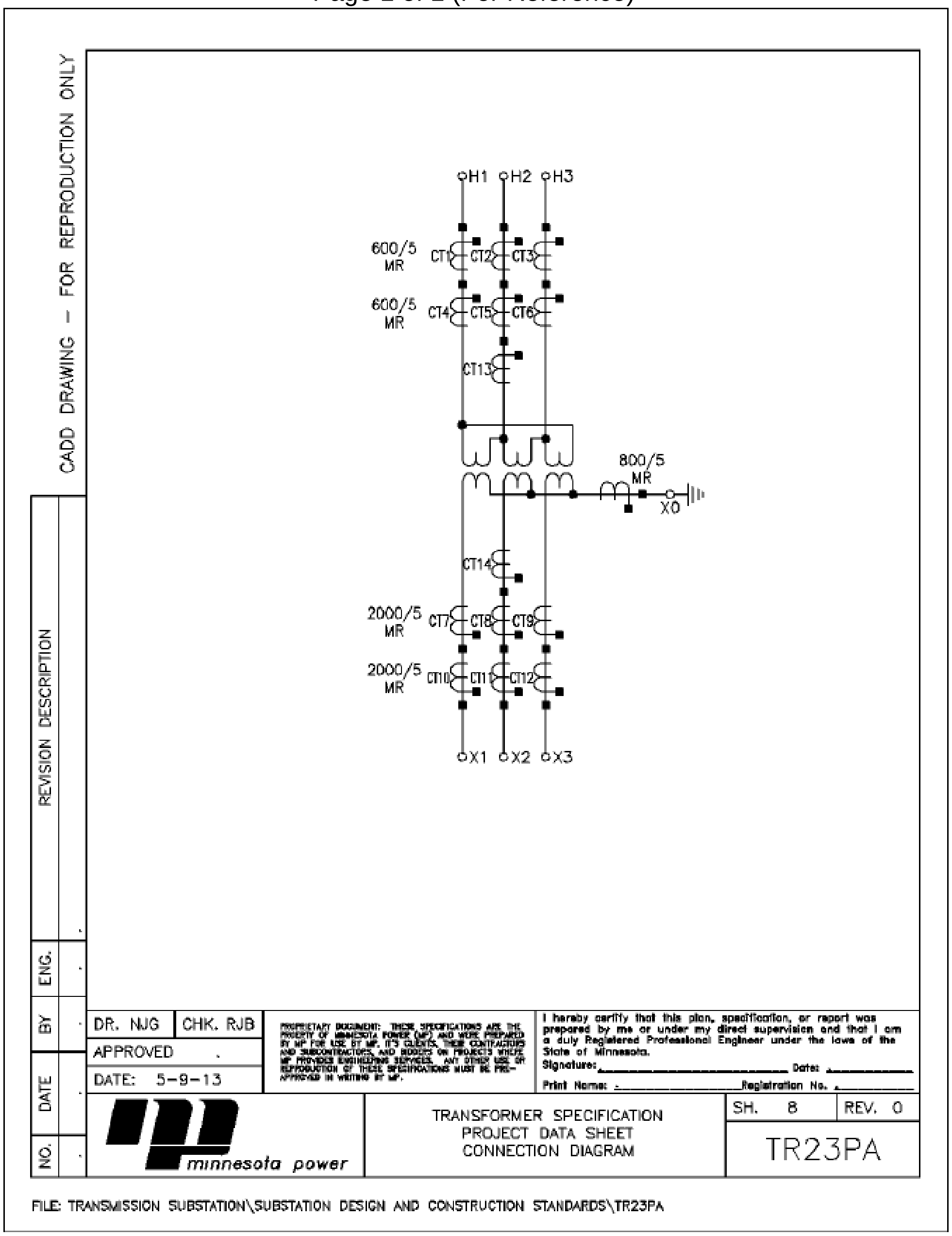
APPENDIX 7
CONNECTION DIAGRAM
GENERAL ALL TRANSFORMERS

Page 1 of 1 (For Reference)



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APPENDIX 8
ALARMS AND MONITORS
GENERAL ALL TRANSFORMERS

REFURBISH	NEW	NO ACTION NOT APPLICABLE	ITEM	MANUFACTURER	CATALOG NO.
	X		MAIN LIQUID LEVEL GAUGE	QUALITROL	CAS-803-1-CS-34345*
			LTC LIQUID LEVEL GAUGE	QUALITROL	CAS-786-2-CS-33348*
	X		LIQUID TEMP GAUGE	QUALITROL	104-330-01*
	X		WINDING TEMP GAUGE	QUALITROL	104-314-01*
	X		PRESSURE VACUUM GAUGE	THUEMLING IND. PRODUCTS	421-552A
	X		MAIN PRESSURE RELIEF DEVICE	QUALITROL	208-009-01*
			LTC PRESSURE RELIEF DEVICE	QUALITROL	208-009-01*
	X		SUDDEN PRESSURE RELAY - Oil	QUALITROL	900-FLA-A-NO-STD*
	X		SUDDEN PRESSURE RELAY - Gas	QUALITROL	910-FLA-A-NO-STD*
	X		RELIEF DEVICE SEMAPHORE	QUALITROL	207-60-3*
	X		PRESSURE VACUUM SWITCHES	QUALITROL QUALITROL	146-036-01* 146-036-02 6-02
	X		OIL FLOW INDICATOR	QUALITROL	092-301-03*
	X		LOSS OF POWER RELAY (FANS)	TELEMECANIQUE	CADREQ3836G3 LADR26
	X		LOSS OF POWER RELAY (COOLING CTRL)	TELEMECANIQUE	CADREQ3836G1 LADR26
		X	LTC SUDDEN PRESSURE RELAY – OIL	QUALITROL	900-FLA-A-NO-STD*
	X		SUDDEN PRESSURE AUXILIARY RELAY – 125VDC	GE	HFA151B5H
		X	SUDDEN PRESSURE AUXILIARY RELAY – 120 VAC	GE	HFA151B9H
	X		LOSS OF POWER RELAY - SUDDEN PRESSURE CIRCUIT	POTTER & BRUMFIELD	KRPA-11DY-110
			* or equal		

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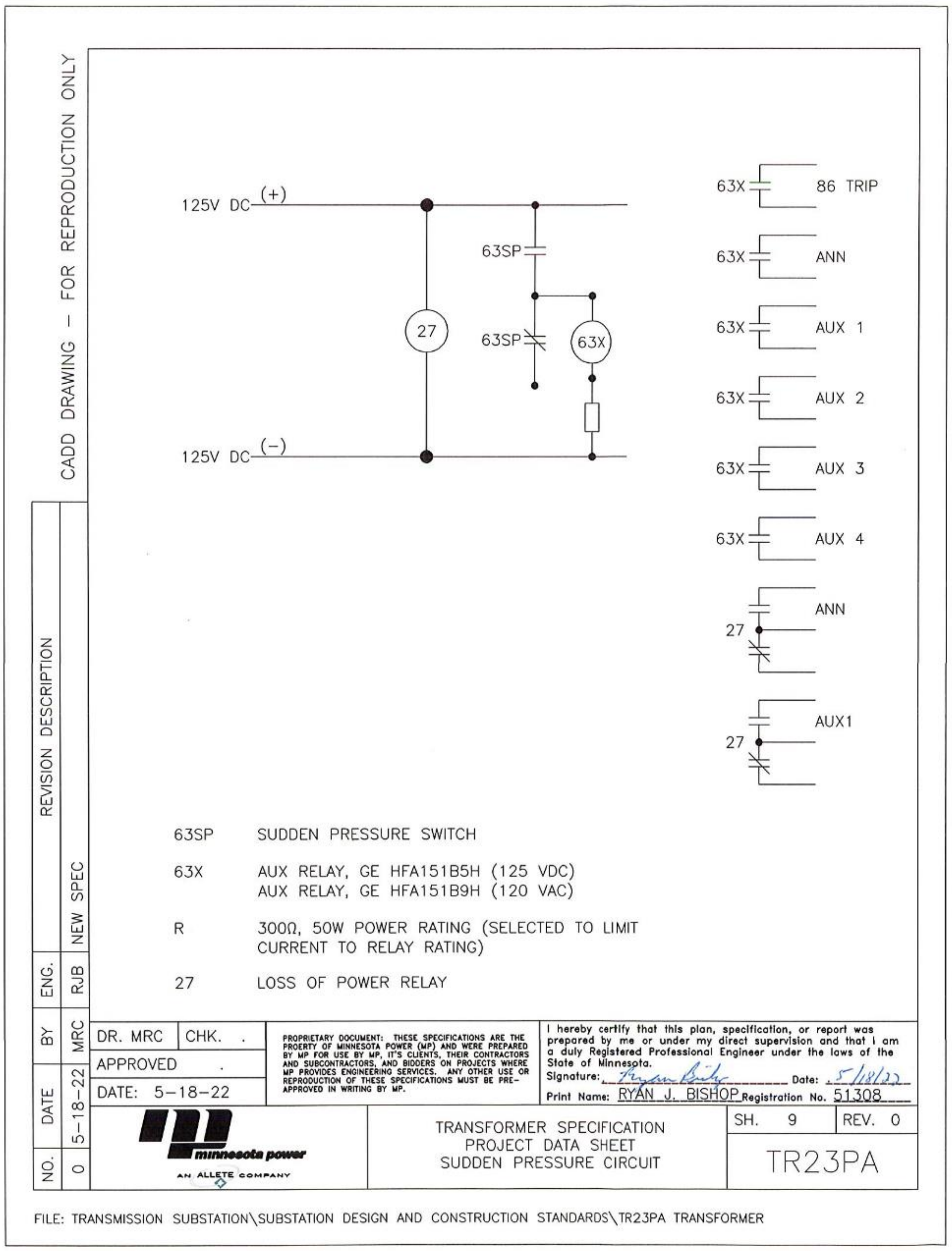
APPENDIX 9
SUDDEN PRESSURE DIAGRAM – GENERAL ALL TRANSFORMERS



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APPENDIX 10
CONTROL POWER SUPPLY DIAGRAMS
GENERAL ALL TRANSFORMERS

_______ Minnesota Power Drawing CR10.05.121587 for typical power supply wiring is attached.

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APPENDIX 11
Transformer Design Considerations
GENERAL ALL TRANSFORMERS

22.0 EXHIBIT 9 - MP CONTROL STANDARDS AND SPECIFICATIONS

Site

Project

MINNESOTA POWER

STANDARD EQUIPMENT SPECIFICATION

FLAME RETARDANT POWER & CONTROL CABLE

Date	Prep
XX/XX/XX	BAH

Standard Number

CA01PA

(Rev 1)

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4. TESTS 3

5. DOCUMENTATION 5

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7. REVISION TABLE 7

1. SCOPE

This specification covers flame retardant power and control cable. This includes but is not limited to control cable used for AC Signals, low voltage AC distribution circuits, and DC controls.

2. REFERENCE STANDARDS

The design, materials, manufacturing and testing of electrical cables shall comply with the latest revisions in effect as of date of manufacture of all currently approved applicable regulations, safety codes, specifications and standards, including technical definitions, whether or not specifically mentioned herein. The applicable codes/standards shall include, but not necessarily be limited to, the following:

These set forth the minimum requirements:

ASTM B3	Standard Specification for Soft or Annealed Wire
ASTM B8	Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B33	Standard Specification for Tinned Soft of Annealed Copper Wire for Electrical Purposes
ICEA S-66-524	ICEA/NEMA Standards Publication Cross-linked-Thermosetting-Polyethylene-Insulated Wire and Cable for Transmission and Distribution Electrical Energy
ICEA P-46-426	Power Cable Ampacities
ICEA P-54-440	Ampacities: Cables In Open Top Cable Trays
ICEA S-68-516	ICEA/NEMA Standards Publication Ethylene Propylene-Rubber Insulated Wire and Cable for Transmission and Distribution Electrical Energy
ICEA T-29-520	Guide for Conducting Vertical Cable Tray Flame Tests with Theoretical Heat Input of 210,000 BTU/HT
ICEA P-53-426	Ampacities Including Effect of Shielding for Single Conductor Solid Dielectric Power Cable 15kV through 69kV Copper and Aluminum Cables
ICEA S-73-532	ICEA/NEMA Standard Publication "Control Cable"
ICEA S-82-552	ICEA/NEMA Standards Publication "Instrumentation Cable and Thermocouple Wire"
WC-26-90	NEMA Standard Wire and Cable Packaging
UL 1581	Reference Standard for Electric Wires, Cables and Flexible Cords
UL 44	Rubber Insulated Wires and Cables
UL 1277	Electric Power & Control Tray Cables with Optional Optical Fiber Members
IEEE 98	Standard for the Preparation of Test Procedures for the Thermal Evaluation of Solid Electrical Insulating Material

IEEE 99	Recommended Practice for the Preparation of Test Procedures for the Thermal Evaluation of Insulation Systems for Electrical Equipment (where specified)
IEEE 101	Guide for the Statistical Analysis of Thermal Life Test Data IEEE 383 Standard for Type Test of Class 1E Electric Cables, Field Splices and Connections for Nuclear Power Generating Stations (where specified)
IEEE 383	Standard for Type Test of Class 1E Electric Cables, Field Splices and Connections for Nuclear Power Generating Stations (Sect. 2.5)
OSHA	

3. TECHNICAL REQUIREMENTS

3.1 GENERAL

3.1.1 The multiple conductor cable shall be suitable for AC and DC control, relay and instrument circuits. It shall be suitable to be installed in exposed conduits, cable tray, ducts above and below grade and wet or dry locations.

3.1.2 The multiple conductor shielded cable shall be suitable for exposed conduit, tray, underground ducts above and below grade in wet or dry service. When paired cables are specified, the pairs shall be individually shielded.

3.1.3 The single conductor cable shall be suitable for AC and DC power circuits, motor circuits, heater circuits and lighting. The single conductor cable shall be suitable to be installed in exposed conduits, cable tray, ducts above and below grade and wet or dry locations.

3.1.4 Single conductor cable shall be jacketed and insulated.

3.1.5 The cable, insulation and jacket, shall be suitable for installation at -20°C.

3.2 CONDUCTOR

3.2.1 Conductors shall be stranded, uncoated, annealed copper, meeting ASTM B-3, B-8 and ASTM Class B.

3.2.2 The required number of conductors are to be cabled round with a nonhydroscopic filler, flame resistant, for circular configuration.

3.2.3 For multiple conductor cable the effect of stray magnetic fields shall be minimized by constructing the cable with twisted conductor configuration.

3.3 CONDUCTOR INSULATION

3.3.1 Conductor insulation shall be cross linked polyethylene or ethylene propylene rubber (preferred), rated 600 Volts, (or 300 Volt where specified) and conform to ICEA/NEMA standard ICEA S-66-524, S-68-516.

3.3.2 The insulation shall be thermosetting type suitable for continuous operation at a conductor temperature not to exceed 90°C (194°F) in an ambient temperature not to exceed 40°C (104°F) and shall be flame and moisture resistant, meeting the electrical and physical requirements of above listed standards. The insulation shall meet the requirements of section 2

3.3.3 The insulation thickness shall be in accordance with applicable ICEA standards for the rated voltage and conductor size.

3.3.4 Conductor insulation (multiple conductor cables) shall be color coded as per ICEA Method 1 using colored compounds with tracers. No other method is acceptable. The color sequence shall be in accordance with standard ICEA S-73-532. Appendix E, Table E-2. The base and tracer colors shall match the color shades as given in Table K-2 in Appendix K of the same standard.

3.3.5 All conductors shall be insulated including ground wires.

3.4 CABLE JACKET

3.4.1 Jacket to be permanently marked with manufacturers' identifications, cable size, and ratings at approximately two foot intervals. The overall jacket shall be in accordance with standard ICEA S-68-516 Table 4.4, 4.5 and 4.6. The jacket shall meet the requirements of section 2.

3.4.2 Jacket shall be oil, heat, weather, flame, abrasion and moisture resistant, meeting the physical requirements of ICEA standards. If a jacket material not covered in ICEA standards is offered, Seller shall furnish its physical characteristics in such a way as to permit a direct comparison with those of ICEA jackets.

3.4.3 Polyvinyl chloride (PVC) jacket is not acceptable for any cable construction. The jacket material shall be less than 20% chlorine content by weight. The jacket material may be neoprene, rubber, chlorosulphonated polyethylene, hypalon, non-halogenated cross linked polyolefin, chlorinated polyethylene (CPE) or other materials which meet the requirement stated above.

3.5 CABLE SHIELDING

Electrostatic shielding methods (listed in order of preference).

3.5.1 Aluminum coated nylon or polyester with tinned annealed copper drain wire. Drain wire to be same size or two AWG size smaller than insulated conductors and to be in continuous contact with the aluminum shield.

3.5.2 Copper coated nylon or polyester with untinned annealed copper drain wire. Drain wire to be same size or one gauge size smaller than insulated conductors and to be in continuous contact with copper shield.

3.5.3 5 mil copper tape shield

4. <u>TESTS</u>

4.1 GENERAL

4.1.1 Minnesota Power reserves the right to witness any and all tests or inspections. Vendor shall notify Minnesota Power 10 days in advance of any inspection or tests required by this specification. Minnesota Power will advise in writing as to which tests or inspection will be witnessed.

4.1.2 The cables shall meet the qualification tests, acceptance tests and tests on completed cable as outlined in ICEA S-66-524 or S-68-516 and IEEE 383, IEEE 101, UL 1277, ICEA T-29-520.

4.2 FACTORY INSPECTION

4.2.1 Tests on completed cables shall be performed on the shipping reel lengths before shipment. Minnesota Power shall reserve right to witness these tests. He may reject any portion of the cables being tested which do not meet the specification. Vendor shall furnish certified test reports if Minnesota Power waives the right to inspect the cable.

4.3 QUALIFICATION TESTS

4.3.1 The qualification tests shall be made on the cable or a representative sample to demonstrate the fabricated cable design conforms to the specification. Those tests are:

4.3.1.1 Long Term Aging Test. The cable shall have a projected 40 year life in (at 90°C) accordance with IEEE 98,IEEE 99, IEEE 101 and IEEE 383.

4.3.1.2 Accelerated Water Absorption Test. These tests shall be conducted per ICEA S-68-516 or S-66-524.

4.3.1.3 Accelerated Water Absorption Test. (Jacket) These Tests shall be conducted per ICEA S-68-516 or S-66-524. The water absorption shall not exceed 40 mg. per square inch of surface

4.3.1.4 Heat Distortion Tests. These tests shall be conducted per ICEA S-68-516 or S-66-524.

4.3.1.5 Oil Immersion Test. These tests shall be conducted per ICEA S-68-516 or S-66-524.

4.3.1.6 Flame Retardancy. These tests shall be conducted per UL 1277, IEEE 383 and/or ICEA T-29-520 and demonstrate flame retardancy to a 210,000 BTU, heat source.

4.4 ACCEPTANCE AND FACTORY TESTS

4.4.1 Acceptance and Factory Tests shall be per ICEA S-68-516 or S-66-524.

4.5 TESTS ON COMPLETED CABLES

4.5.1 Voltage Proof Tests - Completed reels of cables shall be tested following the general procedures of ICEA S-68-516 Section 6.27 or ICEA S-66-524 Section 6.14. Control cable shall be tested following ICEA S-73-532 section 3.4.

4.5.2 Insulation Resistance - The insulation resistance shall be measured as per ICEA S-68-516 Section 6.28 or S-66-524 Section 6.15. Control cable shall be measured as per ICEA S 73 532 section 3.5.

4.5.3 Partial Discharge - The insulation shall meet the requirements of S-66-524 Section 6.16.

5. DOCUMENTATION

5.1 INFORMATION REQUIRED WITH PROPOSAL

Manufacturer shall provide the following:

5.1.1 A statement of compliance with the specification shall be furnished if Vendor complies with all requirements of these specifications. Vendor shall also furnish copies of certified test reports required in these specifications. List all exceptions to the specification.

5.1.2 Ampacity data for conduit, underground duct and different depths of tray fill installations, if deviating from those of ICEA P-46-426 and P-54-440 standards.

5.1.3 Cable emergency overload and short-circuit ratings.

5.1.4 Vendor's recommendations for cable installation, including minimum installation temperature.

5.1.5 Month and year the cable was manufactured.

6. PACKAGING AND DELIVERY

6.1 REEL AND CABLE PACKAGING

6.1.1 Seller shall prepare all cable reels covered by this specification for shipment in such a manner as to protect them from damage in transit, and shall be responsible at his own expense for any and all damage caused by improper preparation.

6.1.2 Vendor shall furnish cable on nonreturnable wood reels. These shall withstand all the effects of shipment, handling in the field, and outdoor storage for a period of one (1) year in all handling and installation of the cables without damage to the cable or reel itself. Plywood flange reels are not acceptable. The nonreturnable wood reels shall meet the requirements of NEMA Standards Publication No. WC-26-90. Protective coverings for reels shall meet the requirements of NEMA Standards Publication No. WC-26-90. The minimum diameter of the drum of the shipping reels shall be not less than prescribed in NEMA Publication No. WC-26-90. There shall be no damage and no corrosion in the completed cable when shipped. The reels shall be lagged or covered with suitable material to provide physical protection for the cables during transit and during storage and handling operations.

6.1.3 Both cable ends shall be sealed against entrance of moisture prior to shipping. Cables shall be sealed with tight-fitting heat shrinkable end caps.

6.2 REEL MARKING

6.2.1 Each cable reel shall be marked on both sides with indelible lettering or tag as follows:

6.2.1.1 Reel no. (minimum 1-inch high). This reel number shall consist of the Minnesota Power Cable Item No. and Reel No., ie, for Item No. C-12-3 and Reel No. 2, the Reel lettering is C-12-3-2.

6.2.1.2 PO number/supplement

6.2.1.3 Cable symbol

6.2.1.4 Cable voltage, No. of conductors, size

6.2.1.5 Reel length

6.3 CABLE MARKING

6.3.1 Completed cable to be furnished under this specification shall be identified by the printed marking applied to the outside surface. This marking is to include the following information:

6.3.1.1 Manufacturer's name

6.3.1.2 Number of conductors/pairs

6.3.1.3 Shield (if applicable)

6.3.1.4 Size of conductor

6.3.1.5 Conductor material

6.3.1.6 Insulation material

6.3.1.7 Voltage rating

6.3.1.8 Temperature rating (if cable is UL listed omit this marking)

7. REVISION TABLE

Number	Date	By	Reviewed	Description
0	3/29/19	BAH		Converted from old format, No Technical Changes
1	11/6/2023	SDK	Control Meeting BAH, SP, NE, DJ	3.3.5 All Conductors shall be insulated including ground wires

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Site

Project

MINNESOTA POWER

STANDARD EQUIPMENT SPECIFICATION

ELECTRICAL EQUIPMENT ENCLOSURE

FACILITIES AND STRUCTURE

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Signature:___________________________________

Typed or Printed Name: Name Here
Date: January 1, 2018 License No.: #####

Date	Prep
XX/XX/XX	XXX

Standard Number

EEE02CD

(Rev 0)

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1. SCOPE

This specification sets forth the minimum technical requirements for an electric equipment enclosure, herein referred to as Electrical Equipment Enclosure (EEE) to be provided to Minnesota Power (Purchaser) by the Supplier. The Supplier shall quote in strict conformance with these specifications. All exceptions to these specifications or any required standard shall be stated and explained in the submitted proposal.

Section 17.3 can be used to look up drawing numbers for references to Purchaser's drawings contained in this specification.

Delivery and installation of the EEE is required by [MM,DD,YYYY].

2. STANDARDS

The apparatus shall be designed, manufactured and tested in accordance with the latest revision of the following:

2.1 Minnesota State Building Code (MSBC)

2.2 Minnesota Energy Code (MEC)

2.3 International Building Code (IBC) as amended and adopted by the state in which the EEE will be installed.

2.4 American Society of Civil Engineers ASCE/SEI 7-10

2.5 National Electric Safety Code (NESC) (IEEE C2)

2.6 National Electric Code (NEC) as amended and adopted by the state in which the EEE will be installed.

2.7 American Welding Society (AWS)

2.8 All other applicable or jurisdictional Codes and Standards (ex. ANSI, IEC, IEC 60529, NEMA, NEMA 250, ASTM, ICEA, IEEE, NFPA, UL, etc.)

3. ENVIRONMENTAL DATA

The EEE shall be designed to meet all rating and performance requirements specified in this document while operating in the site and environmental conditions listed in this document.

3.1 VOLTAGE

3.1.1 The EEE will be used in an outdoor [Insert Substation Voltage] electrical substation.

3.1.2 The equipment shall be designed to withstand electrical and magnetic fields and transients that are present in an electrical substation.

3.2 ELEVATION

3.2.1 The structures and apparatus designed herein shall be rated for use at an altitude of less than 3000 feet.

3.3 TEMPERATURE

3.3.1 Maximum ambient temperature recorded is XX°F

3.3.2 Maximum daily average ambient temperature is XX°F

3.3.3 Minimum ambient temperature recorded is -XX°F

3.3.4 Minimum daily average ambient temperature is -XX°F.

3.4 LOADINGS

3.4.1 The required Ultimate Design Wind Speed (3 second gust) is 120 mph, using Risk Category III and Exposure Category C.

3.4.2 Ground Snow Load of 60 lbs/ft^2, using an Exposure Factor of 1.0.

3.4.3 Floor Live Load of 350 lbs/ft^2 throughout, unless noted otherwise.

3.4.4 Walls and wall framing shall be capable of supporting a concentrated wall loading of up to 175 lbs. to support hanging of equipment at any location, with a minimum eccentricity of 3 inches measured from the interior face of the wall.

3.4.5 Seismic Design: Per site requirements.

4. GENERAL DESCRIPTION

4.1 Supplier shall be responsible for all required work including the furnishing (See Section 17.3), delivery (See Section 13), and installation/erection (See Section 14) of one (1) pre-assembled, pre-engineered, complete steel EEE acceptable for the intended use as specified herein.

4.2 Supplier shall design, prepare plans and specifications, furnish all materials, provide supervision and construct the EEE including the auxiliary systems and lighting.

4.3 Supplier shall supply plans and calculations stamped and signed by a Licensed Professional Engineer for the state where EEE is to be installed, and is responsible for obtaining all Approvals, Third Party Inspections, and State Industrial Building Commission Approvals if required by the state or local jurisdiction in which the EEE is installed.

4.4 Supplier shall complete all internal control panel wiring and all interconnection wiring.

4.4.1 If interconnection wiring must be disconnected during shipment, Supplier is responsible for termination and retesting continuity of this wiring upon delivery.

4.5 Building materials, equipment and fittings shall be suitable for industrial use and require minimal maintenance. Materials, equipment and fittings which are available in the continental United States are preferred to facilitate future maintenance.

4.6 The materials used to construct the EEE shall be new, unused, and fabricated in a workmanlike manner in a factory environment.

4.7 The EEE structure shall contain all the equipment indicated in this specification and associated drawings (See Section 17.3) making up part of this specification.

4.8 The EEE shall be fully assembled and suitable for human occupancy upon completion of installation.

5. ELECTRICAL SYSTEMS

5.1 ELECTRICAL WIRING METHODS AND MATERIALS

5.1.1 All grounding, workmanship and materials shall conform to the NEC and NESC as outlined in Section 2.

5.1.2 If conduit is used, it shall be electrical thin wall metallic tubing (EMT) except service runs which may be run in cable troughs and flexible metallic conduit used for motor and fixture connections.

5.1.3 All cable and conductors shall meet Minnesota Power Standard Equipment Specification CA01PA, Flame Retardant Power & Control Cable.

5.1.4 All interior conductors shall be low-halogen, flame-resistant, 600V rated EPR cables for all applications other than the electrical switchgear assembly wiring.

5.1.5 All interior junction boxes shall be NEMA Class 1.

5.1.6 All wiring, cable troughs, and conduit shall be surface-mounted and run tight to walls and ceiling with adequate clamps and supports.

5.1.7 All cable splices and terminations shall be on terminal blocks.

5.2 AC STATION SERVICE

5.2.1 AC Station service shall be single phase 120/240V.

5.2.2 The normal station service source will be provided by Purchaser from a XXX kV Station Service Voltage Transformer in the station yard.

5.2.3 The alternate station service source is supplied by Purchaser from a pad mount step-down transformer located inside the substation fence.

5.2.4 Each AC Station Service source shall either enter the EEE through wall penetrations via a 3” Rigid type LB conduit body into an Automatic Transfer Switch or via Service Disconnect Switches into an Automatic Transfer switch as shown on the Electrical Equipment Enclosure (EEE) Layout Plan drawing.

5.2.5 Metering CT Cabinet(s) shall be provided on the outside of the EEE if shown on the Electrical Equipment Enclosure (EEE) Layout Plan drawing and wired as shown in the provided Purchaser schematics (See Section 17.3).

5.2.6 AC Distribution Panels shall be furnished in accordance with Minnesota Power Specification PN03PA, Distribution Panel – 120/240 Volt, 600 Volts or Less AC.

5.3 DC STATION SERVICE

5.3.1 The EEE shall have 130VDC power for all control functions. The 130VDC Battery System shall include:

5.3.1.1 130VDC 58 Cell Battery String

5.3.1.2 130VDC Battery Charger meeting the requirements of Minnesota Power Standard Specification SB02PA, Battery Charger

5.3.1.3 Midpoint fuse, holder, and fiberglass enclosure with viewing window

5.3.1.4 Grounded battery rack, spill containment, and neutralizing pillows

5.3.1.5 Honeywell Fendell 1000 Eyewash Station, Cat. No. 32-001000-0000

5.3.1.6 Honeywell Fendell Eyewash Cartridge, 3.5 gal., PK2, Cat. No. 32-001005-0000

5.3.1.7 Supplier shall provide all other items related to the battery system including items as required by Minnesota Power Standard Specification SB01PA, Lead Storage Battery.

5.3.2 The eyewash station shall be installed in close proximity to the 130VDC battery string.

5.3.3 The 130VDC Battery Charger float and equalize voltages shall be set per the Battery Manufacturer's recommendation for the cell type and quantity installed.

5.3.4 A Wall Penetration for battery system test cables and temporary battery trailer connection cables to be provided

5.3.4.1 Wall Penetration to be 3" capped UV resistant PVC and located between the battery rack and safety switch

5.3.5 DC distribution panel(s) shall be furnished per the 125VDC Distribution Diagram drawings in accordance with Minnesota Power Specification PN02PA, Distribution Panel 125 Volt DC and located per the Electrical Equipment Enclosure (EEE) Layout Plan drawing.

5.4 LIGHTING

5.4.1 The EEE shall have normal and emergency lighting.

5.4.2 Emergency lighting shall be designed and installed to deliver not less than 1fc at floor level in all areas of the EEE with a 90-minute back-up.

5.4.3 Emergency lighting system shall be self-contained with a five (5) year life, containing no nuclear reactive substances or isotopes.

5.4.4 No emergency lighting circuits shall emanate from the 130VDC Battery System.

5.4.5 The normal lighting shall be designed to deliver not less than 50fc at desk level in all areas of the EEE.

5.4.6 Illuminated Exit Signs shall be provided

5.4.7 Both normal and emergency light fixtures shall be LEDs and have diffuser covers.

5.4.7.1 LED light color temperature shall be 5000k

5.4.8 Light switches shall be 20A, three way, wall-mounted with standard cover plates, mounted at 44" above the floor, and placed conveniently near the entrances to the EEE.

5.4.9 The EEE shall have vandal-resistant, photo-eye-sensor-controlled exterior LED lighting to illuminate all entryways into the EEE, set to automatically be on from dusk until dawn.

5.5 GROUNDING

5.5.1 Any steel structure supplied as part of the EEE shall be permanently and solidly grounded to the ground bus or grounding conductor referenced in section 5.5.2.

5.5.2 A ground bus or grounding conductor shall be provided in the EEE to ground all communication, control and SCADA panels, and all AC and DC distribution panels.

5.5.2.1 The grounding conductor or grounding bus shall be placed at the top of the walls near the ceiling.

5.5.3 The ground lugs shall be an integral part of the steel and shall not be bolted to the frame.

5.5.4 Ground lugs to be indicated on the submitted drawings.

5.5.5 The exterior of the EEE shall have grounding pads at each corner of the EEE.

5.5.6 The raceway system shall not be considered to be a ground conductor except for grounding of itself.

5.5.7 All metal conduits containing power circuits shall be provided with grounding type bushings and shall be wired together inside enclosures and connected internally to the enclosure grounding pad or grounding bus with bar copper conductor.

5.5.7.1 The grounding bushing ground conductor shall be sized in accordance with NEC or other internationally recognized standards but shall not be less than #8 AWG bare copper conductor.

5.5.8 Ground conductors shall be soft drawn, bare stranded copper strand class B as defined in NEMA WC 3 (formerly ICEA S-19-81) (or Class II in IEC 60228).

5.5.9 All clamps, conductors, bolts, washers, nuts, and other hardware used with the grounding system shall be copper.

5.6 CONTROL, RTU, HMI/ALARM, COMMUNICATION, METERING & TERMINATION PANELS

5.6.1 Refer to the Electrical Equipment Enclosure (EEE) Layout Plan drawing for the necessary panel line-up and placement.

5.6.2 The panels shall meet Minnesota Power Standard Equipment Specification PN01PA, Control Panels.

5.6.3 The panels shall be installed and delivered with the EEE by the Supplier.

5.6.4 Panels will be individually grounded to the cable tray and connected as shown on the panel drawings provided by the Purchaser (See Section 17.3)

5.6.5 The Termination Panel(s) shall have the following features:

5.6.5.1 LED lighting switched ON/OFF via door contacts

5.6.5.2 Designed for bottom cable entry or as shown on the termination cabinet drawing provided by the Purchaser (See Section 17.3)

5.6.5.3 A 10 gauge aluminum removable bottom cover plate for the termination panel floor opening

5.6.5.4 The location of the termination panel(s) may be subject to change due to foundation design.

5.7 EEE ALARM ENCLOSURE

5.7.1 The EEE Alarm Enclosure shall be wall-mounted 12" x 12" NEMA 1 enclosure, with terminal blocks mounted and alarms wired as outlined in Section 5.7.3.

5.7.2 The EEE Alarm Enclosure shall be mounted in close proximity to the telco plywood board.

5.7.3 The following alarms shall be wired to the EEE Alarm Enclosure:

5.7.3.1 Fire Alarm: Ceiling-mounted, 120VAC smoke detector(s) and relay(s) shall be installed; contacts shall be interlocked to disable HVAC system(s) and exhaust fans(s).

5.7.3.2 Intrusion Alarm: Each door shall have a magnetic contact entry alarm that provides two (2) closed contacts for an open door condition per Section 6.5.5.2

5.7.3.3 High Temperature Alarm: One (1) high temperature alarm shall be provided.

5.7.3.4 Low Temperature Alarm: One (1) low temperature alarm shall be provided

5.7.3.5 Hydrogen Detector Alarm: Alarm on Hydrogen concentrations 2% or greater per Section 6.14.6.2.

5.8 RECEPTACLES

5.8.1 Interior convenience outlets shall be wall-mounted 20A, 120VAC duplex receptacles installed at 18" above floor level with cover plates.

5.8.2 Supplier shall determine number and placement of receptacles and indicate on approval drawings.

5.8.3 Exterior weatherproof, 20A, 120VAC, GFCI duplex convenience outlets shall be provided at each corner of the EEE.

5.8.4 At least one exterior weatherproof, 20A, 120VAC, GFCI duplex convenience outlet shall be installed next to air conditioner(s) and at any other locations to be indicated by Supplier on the approval drawings.

5.8.5 The ground wire for the receptacles shall be insulated over its entire length.

5.9 GPS ANTENNA

5.9.1 A GPS Antenna shall be provided and mounted on a south facing gable end facing cell tower with 360 degree sky exposure and shall extend above the roofline a minimum of 2 feet.

5.9.2 The GPS Antenna surge protector is to be mounted on the inside of the wall in close proximity to the wall penetration.

5.9.3 The conduit on the outside of the EEE shall include a junction (conduit STYLE TB) to allow the exit of a cable for cellular phone repeater antenna at communication cable tray level. The conduit is to be 1” diameter.

5.10 EXTERNAL TELEPHONE RINGER

5.10.1 An external telephone ringer shall be provided on the wall facing the substation per the Electrical Equipment Enclosure Layout Drawing and Communication Panel Bill of Material Drawing.

5.10.2 A wall penetration for the cable to the external telephone ringer shall be provided via 1” conduit.

5.11 TELEPHONE CONNETIONS

5.11.1 Conduits and CAT 5e cabling shall be provided from each door location to the Communication Panel.

5.11.2 Conduits and CAT 5e cabling shall be provided from the Communications Panel to the desk phone location

5.11.3 Quad Junction Boxes shall be provided at each phone location.

6. MECHANICAL SYSTEMS

6.1 Heavy duty lifting plates or similar hardware shall be supplied and mounted to the base as needed for lifting the EEE.

6.2 FOUNDATION LOADING

6.2.1 The EEE foundation (drilled piers or slab-on-grade) will be designed by Purchaser.

6.2.2 The Supplier shall provide all static and dynamic loading calculations, foundation reactions, and all critical mounting features for the EEE to Purchaser 2 weeks ARO.

6.2.3 Supplier to provide foundation loads for both drilled pier and slab-on-grade foundation options.

6.2.4 For the drilled pier option, Supplier to provide the assumed or maximum drilled pier spacing.

6.3 ENERGY USE AND INSULATION

6.3.1 The EEE shall be designed and insulated to meet all requirements of the most current version of the code listed in Section 2.2. Including thermal spacer blocks or similar thermal breaks as part of the building envelope requirements as required by the referenced code.

6.3.2 The following minimum insulation values are required:

6.3.2.1 Walls: R-20 + R-13 Continuous Insulation

6.3.2.2 Roof: R-30 + R-11 Liner System and R-5 Thermal Blocks

6.3.2.3 Floor: R-38

6.3.2.4 Doors: R-15

6.4 INGRESS AND EGRESS

6.4.1 The EEE shall have two (2) single-door entrances/exits.

6.4.2 One single-door entrance/exit shall be a nominal minimum opening size of 48"W x 96"H and the other single-door entrance/exit shall be a nominal minimum opening size of 36"W x 84"H taking into account the frame height.

6.4.3 Entrance/exit doors shall swing out and be equipped with panic bars, safety chain, pressure plates, or other devices that are normally latched but open under simple pressure.

6.4.4 All doors shall be completely weather-stripped.

6.5 DOORS AND FRAMES

6.5.1 Doors shall comply with Steel Door Institute directive SDI-100.

6.5.2 Doors shall have an insulated core and be constructed of no less than 18-gauge steel-faced leafs with stiffeners and 16-gauge door frames.

6.5.3 Doors and frames to be hot-dipped galvanized to ASTM-A924 and ASTM-A653, and then factory primed and painted with epoxy enamel to match the EEE or the trim.

6.5.4 The size and quantity of doors are indicated in Section 6.4.

6.5.5 Door Hardware:

6.5.5.1 NRP stainless steel ball bearing hinges, minimum of three (3) per door.

6.5.5.2 Von Duprin 99NL X US26D exit device

6.5.5.3 Von Duprin 990TP thumb latch exterior

6.5.5.4 Schlage large format removable core rim cylinder lock

6.5.5.5 GE Interlogix 1076D DPDT steel door contact

6.5.5.6 Door closer with hold open arm

6.5.5.7 Weather stripping and sweep

6.5.5.8 Removable threshold (for double wide doors only)

6.5.5.9 Watershed, at top of door

6.5.5.10 Drip cap, extending 3" past door edge

6.5.5.11 Safety chain to limit door swing

6.5.6 Door Lock Boxes

6.5.6.1 Manufacturer shall supply a wall-mounted lock box mounted on the external of the building near doors to store the door key. Refer to the Electrical Equipment Enclosure (EEE) Layout Plan drawing for locations.

6.5.6.2 The lock boxes shall be capable of being securely locked by Purchaser provided padlocks.

6.5.6.3 The door key shall be affixed to the inside of the lock box by a retaining chain long enough to unlock the entrance door to the EEE while the key is affixed to the retaining chain.

6.5.6.4 The lockbox shall be placed at a height in close proximity to the door lock.

6.6 EXPANSION

6.6.1 The EEE [shall/shall not] be required to be expandable in one direction for possible future substation expansion. Refer to the Electrical Equipment Enclosure (EEE) Layout Plan drawing.

6.7 DESIGN REQUIREMENTS

6.7.1 The structure design and manufacture shall, at a minimum, conform to the Codes and Standards listed in Section 2 of this Specification.

6.7.2 The entire structure including primary framing, secondary framing and cladding, shall be designed in accordance with the IBC as adopted and amended by the current applicable State Building Code. The structure shall be designed utilizing Occupancy Category III.

6.7.3 Structural Load Combinations shall be in accordance with the IBC (ASD or LRFD).

6.8 EXTERIOR TREATMENTS, WALLS, AND ROOF

6.8.1 The EEE shall have a complete, internal, self-supporting, structural steel frame that meets or exceeds the specified design load criteria without reliance on exterior sheeting, exterior panels, or roof cover panels for its structural strength or framing.

6.8.2 Metal exteriors and roofing shall have a PVDF resin-based paint coating, over either a Galvalume or galvanized substrate, with a twenty (20) year warranty against rust perforation, a twenty (20) year warranty against fading and chalking, and a twenty-five (25) year warranty against flaking, peeling, and checking.

6.8.3 The roof shall be pitched 1 inch in 12 or greater and shall have a roof covering of mechanically-seamed, standing-seam roofing with a minimum seam height of 2". Standing seam roof panels shall be baked-on, resin-base pre-finished steel and shall have no visible fasteners on the main run. Roof to include a matching, die-formed ridge cap, and a fully supported 3" overhang. Properly sized attic space ventilation shall be provided. All attic openings shall be screened to prevent entrance of bees or larger insects or birds.

6.8.4 A steel canopy of sufficient size shall be provided over the entrance doors to prevent ice formation outside the EEE exits during the winter months and to channel rain water from the roof away from the doorway.

6.8.5 Snow guards shall be provided on the roof above positions where equipment is mounted on the exterior of the EEE.

6.8.6 The wall exteriors shall be galvanized steel panels with a PVDF resin-based finish in manufacturer's standard colors. Exterior siding panels to be overlapped and installed with appropriate self-tapping fasteners with integral gaskets, and shall be removable without any disturbance to interior panels.

6.8.7 Butted seams are not allowed.

6.8.8 Repair or replacement of panels must be able to be done entirely from outside the EEE structure.

6.8.9 Exterior trim package shall include stepped or boxed eave, rake, fascia, base, corner, jamb, and header trim in 26 gauge Galvalume material with Purchaser’s choice of standard KYNAR colors.

6.8.10 Hood covers shall be provided on the exterior wall above positions where equipment is installed on the sides of the EEE.

6.9 WALL PENETRATIONS

6.9.1 The ~~vendor~~ Supplier shall provide wall penetrations per the Electrical Equipment Enclosure (EEE) Layout Plan drawing. Unless otherwise stated the following wall penetrations are required:

6.9.1.1 Penetrations for AC Station Service per Section 5.2

6.9.1.2 Penetration for battery system test cables per Section 5.3.2

6.9.1.3 Penetration for GPS antenna and cellular phone repeater cable per Section 5.9

6.9.1.4 Penetration for external telephone ringer per Section 5.10

6.9.2 All openings in walls are to be structurally framed, sleeved, trimmed, watertight, and provided with external drip caps with piping or formed metal of the same composition as the exterior panels.

6.10 INTERIOR TREATMENTS, WALL, CEILING, AND FLOOR

6.10.1 The EEE's interior walls and ceiling shall be lined with flush-fit 24 gauge, roll-formed liner panels, fully reinforced, with concealed fasteners and a baked-on polyester finish over G-90 galvanized substrate.

6.10.2 The EEE interior shall feature a complete matching trim system including base, jamb, header, and ceiling trim. ~~Vendor~~ Supplier to provide color options for both the interior panels and trim.

6.10.3 The ceiling height of the EEE shall be designed to allow the vertically-stacked cable tray design per Section 6.17, with a minimum ceiling height of 10'.

6.11 INSULATED STRUCTURAL STEEL FLOOR SYSTEM

6.11.1 Floor system shall have a hot rolled, welded steel framework, with interior hot-rolled steel or steel tube supports to meet required loads, with maximum live load deflection of L/360 and total load deflection of L/240, and cold formed joists sized and spaced to meet design loads.

6.11.2 Floor insulation system shall be comprised of fiberglass batt insulation or spray closed cell foam between joists, and 2" of continuous extruded rigid polystyrene insulation between joists and the fully hot-dipped galvanized steel rodent and insect barrier.

6.11.2.1 Floor perimeter area and roof perimeter at the wall/roof juncture shall be either dense packed with fiberglass or similar batt or covered with spray closed cell foam.

6.11.3 A fully hot-dipped galvanized steel rodent and insect barrier shall be provided below insulation.

6.11.4 Floor insulation system to provide specified insulation value called out by all applicable codes with a minimum insulation value as listed in Section 6.3.2.3.

6.11.5 Hot-rolled steel shall be ASTM A36, A572 or A992, and shall be galvanized in accordance with ASTM A653. Tube steel shall be hot-dip-galvanized ASTM A500, Grade B.

6.11.6 Steel floor surface shall be welded plate steel of sufficient thickness (1/4" minimum) to support specified design loads and meet the deflection limitations stated above, with a painted, slip-resistant finish.

6.11.7 Floor system shall be designed to be anchored to and supported by [Drilled Piers or Slab on Grade] foundation.

6.11.8 Floor framework and floor deck plates shall be fully chemically cleaned, primed and painted with a self-priming, catalyzed coating system designed to provide an extremely durable finish, suitable for heavy resistance to fading. Paint system shall have a minimum Dry Film Thickness, per coat of 3 - 5 mils. Color to be ANSI 61. Floor shall have a non-slip texture added to paint. Approved coating: Rustoleum High Performance Polyurethane 9800 Urethane Mastic System.

6.11.9 Floor system weld standards shall meet all AWS recommended practices.

6.11.10 Protective temporary floor covering shall be installed and delivered with the EEE made out of corrugated fiberboard with size “A” flute.

6.12 FASTENERS, ADHESIVES, AND SEALANTS

6.12.1 The fasteners, adhesives, and sealants utilized shall be of types approved for use on this type of structure as required by the appropriate agency or governing body, as covered in Section 2.

6.13 CLOSURES

6.13.1 Matching, pre-molded, closed cell elastomer closures provided by the siding and roof panel manufacturer shall be installed according to the manufacturer's recommendations at the eave line, beneath the roof panels, and where the trim meets the wall panels.

6.14 INTAKE AND EXHAUST FAN

6.14.1 Intake to have a filter rack, pleated high-efficiency filter, insect screens and painted steel weather hood.

6.14.2 Exhaust to have a back draft damper, insect screen, and painted steel weather hood.

6.14.3 Intake and exhaust units to be louvered aluminum with motorized dampers

6.14.4 Intake and exhaust to be sized by Supplier based on size of EEE and/or any specific requirements based on battery system being used.

6.14.5 Exhaust fans are not to be mounted directly above the battery bank.

6.14.6 Exhaust fan to be controlled by a manual on-off switch, hydrogen sensor, and a separate wall-mounted thermostat.

6.14.6.1 The Hydrogen Sensor shall be wired to turn on the exhaust fan at 1% Hydrogen concentration and to alarm to the RTU at 2% Hydrogen concentration via the EEE Alarm Enclosure as referenced in Section 5.7. Hydrogen sensor to be mounted on ceiling in close proximity to the batteries, while still being accessible by ladder for testing and replacement. Hydrogen sensor shall not be mounted directly above the batteries.

6.14.6.2 The wall-mounted thermostat shall turn on the fan when temperatures are above the thermostat setpoint.

6.15 DRIP LEDGE AND RAIN GUTTERS

6.15.1 The EEE shall have a drip ledge placed appropriately to encourage water draining off of the roof away from the side of the EEE.

6.15.2 Rain gutters are not acceptable.

6.16 FURNISHINGS

6.16.1 Manufacture shall supply a desk, filing cabinet, storage cabinet, print rack, and two print clamps for placement in the building per the Electrical Equipment Enclosure (EEE) Layout Plan drawing (See Section 17.3).

6.16.1.1 The provided desk shall be HON Company, Right Single Pedestal, Model Number HONP3251RCL or equivalent.

6.16.1.2 The filing cabinet shall be Sandusky Company, 4 Drawer Vertical Letter, MODEL HS384PL or equivalent.

6.16.1.3 The storage cabinet shall be Sandusky Company, 2 door, Model Number VF31301572-07 or equivalent.

6.16.1.4 The print rack and print clamps shall be capable of holding to 12” to 36” wide prints.

6.17 CABLE TRAY

6.17.1 The EEE shall have 24" wide and 18” wide ladder-type aluminum cable tray with 6" rung spacing and 4" loading depth for power and control cables

6.17.2 The EEE shall have 6" wide cable tray with 6” rung spacing and 4" loading depth section for communications cables.

6.17.3 The entire raceway system will be trapeze-supported from the ceiling.

6.17.4 The EEE ceiling shall be reinforced to support the cable tray system with an additional working load of 100lbs/lineal ft.

6.17.5 The cable tray spans shall not exceed manufacturer's recommended distances between support hangers.

6.17.6 Cable tray shall extend to allow cable runs to all panels, including the AC and DC distribution panels.

6.17.7 The EEE Supplier shall maintain sufficient vertical spacing between cable tray and the top of the panels.

6.17.8 The control and power cable tray and communications cable tray shall be vertically stacked.

6.17.8.1 The vertical spacing between cable trays shall be 6”

7. HEATING AND COOLING SYSTEMS

7.1 HEATING, VENTILATION, AND AIR CONDITIONING (HVAC)

7.1.1 Minimum Standards: Unit(s) to be sized by EEE manufacturer to be readily available, wall-mounted, commercial-grade air conditioner with integral heater with a cold weather package if available.

7.1.2 Unit(s) supplied by manufacturer shall have service representation within a 150-mile radius of installation site.

7.1.3 Size and Quantity: The minimum and maximum interior ambient temperatures shall be calculated using ambient site conditions and expected internal heat gains as outlined in Sections 7.2 and 7.3.

7.1.4 HVAC Unit quantity to be determined by the Supplier

7.1.5 Power feed is assumed to be 208/240VAC, single phase unless noted otherwise by manufacturer.

7.1.6 HVAC Unit(s) to have supply and return grilles, and a replaceable pleated high efficiency filter on the return side.

7.1.7 HVAC Unit(s) to be controlled by a separate wall-mounted, auto-change-over thermostat, or a lead-lag controller if two (2) units are used.

7.1.8 Thermostat or controller shall be AC powered.

7.2 HEATING SIZING

7.2.1 The primary heating source is to be thermostatically controlled electric heating and shall be provided, sized, and preset at the factory, to maintain the EEE at a minimum average ambient temperature of 70°F throughout the EEE when subjected to the atmospheric temperature in Section 3.3.4 and Coldest Month 0.4% occurrence wind speed per ASHRAE.

7.2.1.1 The heat load calculations shall be calculated using the initial EEE design thermal gain, not taking into account the ultimate design heat loading.

7.2.1.2 The heating load calculations shall take into account the exhaust fan operation and building ACH (air changes per hour).

7.2.2 Secondary Electric Heater

7.2.2.1 A secondary electric unit heater with controlled by a wall mounted thermostat shall be provided, and preset at the factory, to maintain the

EEE at a minimum average ambient temperature of 40°F throughout the EEE when subjected to the atmospheric temperature in Section 3.3.4 and coldest month 0.4% occurrence wind speed per ASHRAE.

7.2.2.2 A built in thermostat is not acceptable

7.2.2.3 The heating load calculations shall follow Sections 7.2.1.1 and 7.2.1.2

7.2.2.4 The electric unit heater is not to be included in the heating calculations for sizing the primary heat source. The electric unit heater is intended for partial redundancy in the event of a failure of the primary heating source.

7.3 AIR CONDITIONING SIZING

7.3.1 Air conditioning shall be provided, sized, and preset at the factory, to maintain the EEE at a maximum of 80°F with all heat producing sources on during the maximum ambient temperature found in Section 3.3.2 using the ultimate EEE design and following all other ASHRAE requirements.

8. TESTS

The EEE and all associated equipment, amenities, apparatus, spare equipment/parts/tools, and ancillary devices shall be acceptance-tested and function-tested in accordance with all required specific ANSI, NEMA, IEEE, UL, IEC, UBC, IBCO tests or special Purchaser tests that apply.

8.1 Test Reports: Supplier to provide two copies of all test reports in electronic format (i.e. CD-ROM or e-mail). These are required no later than two weeks prior to delivery of the EEE to avoid delays in critical path schedule.

8.2 Supplier to provide any certified test reports required by Purchaser or regulatory bodies.

8.3 Test for protection against ingress of water.

8.4 Supplier to provide option for Building Air Blower Test

9. INFORMATION REQUIRED WITH PROPOSAL

One (1) electronic copy of all proposal drawings and documents are required by close of business four (4) weeks after Supplier acknowledging receipt of RFQ. The following is required to be provided by the Supplier with the submitted proposal:

9.1 EEE outline dimensions, physical requirements, floor plan, interior and exterior dimensions, elevations, suggested foundation elevations and dimensions, and the location of all primary accessories included with the EEE.

9.2 Equipment and electrical performance data, including cut sheets and technical specifications adequate to determine quality of equipment being provided concerning the EEE and all components included as part of the EEE (i.e. HVAC equipment, lights, batteries, battery charger, AC & DC panels, etc.).

9.3 Proof of being in the EEE design and manufacturing business for a minimum of 5 years, and be able to supply proof of supplying at least 25 EEE's of a similar type in that timeframe.

9.4 Mechanical and mechanical performance data

9.5 Shipped and installed weights.

9.6 Mounting provisions and structural loading

9.7 Exceptions to these specifications or any required standards

9.8 Supplier shall state latest date of receipt of order to meet the delivery date stated in Section 1

9.9 Supplier shall state latest date of receipt of schematics from customer to meet the delivery date stated in Section 1

9.10 Outline of all tests which will be performed

9.11 Delivery Date

9.12 Shipment point

9.13 Shipment method

9.14 Schedule of all submittals after receiving order

9.15 Completed Price Breakdown per attached "EEE02CD – Section 9.15 Bid Tab.xlsx"

9.16 Complete Bill of Materials

9.17 Cost for optional Building Air Leakage Test per Section 8.3

10. APPROVAL DOCUMENTS

10.1 Supplier to provide one (1) electronic copy (PDF or AutoCAD) of design loads for [Drilled Piers or Slab on Grade] foundation design, all static and dynamic loading calculations, foundation reactions, and all critical mounting features for the EEE to Purchaser 2 weeks ARO.

10.2 One (1) electronic copy (PDF or AutoCAD) of all other approval documents are required by close of business within 4 weeks ARO. Approval documents shall include:

10.2.1 Bill of Material

10.2.2 Outline

10.2.3 Mounting and Moving Provisions

10.2.4 Schematics

10.2.5 Nameplate

10.2.6 Other rating data furnished with Section 9.

10.2.7 A standard color chart shall be provided to Purchaser for interior and exterior color selection prior to manufacturing.

10.2.8 Door and door frame details.

10.2.9 Roof and wall sections with proposed framing

10.2.10 Design loads for Foundation Design.

10.2.11 HVAC Calculations

10.2.12 Secondary Heating Calculations

10.2.13 Structural Submittals: The structure manufacturer shall submit a structural design criteria document stating the basis of structural design in the form of a drawing, letter or calculation package, certified by an Engineer licensed in the state of the project. Fabrication of the structure shall not commence until this document has been reviewed and approved by the Purchaser. This document shall include, as a minimum, the following items:

10.2.13.1 Live Loads: Floor and roof live loads.

10.2.13.2 Snow Loads: Ground snow load, flat-roof snow load, exposure factor, importance factor and thermal factor.

10.2.13.3 Wind Loads: Ultimate and nominal design wind speeds (mph), risk category, exposure category, internal pressure coefficient and components and cladding wall and roof wind pressures (psf).

10.2.13.4 Seismic Loads (if applicable): Risk category, importance factor, mapped spectral response acceleration parameters, site class (assume D unless other information is provided), seismic design category, basic force resisting system(s), design base shears, seismic response coefficients, response modification coefficients and analysis procedure used.

10.2.13.5 Base support frame layout including dimensions, maximum foundation support spacing (assuming support by multiple drilled pier foundations).

10.2.13.6 Foundation reactions for both drilled pier and slab foundation options. Identify whether foundation reactions are service load or factored reactions, and provide breakdown of forces by load type. Include maximum vertical compressive and uplift forces, shear and moment (if applicable), including units. Include recommended or maximum support spacing for drilled pier foundation option.

10.2.13.7 Structural framing and floor plate deflection calculations or written statement outlining maximum live and total load deflections as a ratio of element length.

10.2.14 Anchor bolt and clip drawings

11. RECORD DOCUMENTS

One (1) electronic copy (i.e. CD-ROM, e-mail) of all record drawings are required by close of business no later than two weeks prior to EEE delivery date. Electronic documents shall be in PDF and AutoCAD format. One (1) paper copy is required to be shipped with the EEE.

11.1 The following are required record documents:

11.1.1 Photos of the following before liners or flooring material are installed:

11.1.1.1 Floor, wall, and ceiling assemblies while open

11.1.1.2 Floor rim area

11.1.1.3 Roof / wall juncture

11.1.2 A copy of the production (routine) tests

11.1.3 Instruction, installation and maintenance manuals

11.1.4 Manufacturer's drawings of equipment supplied

11.1.5 EEE Supplier as built control and layout drawings

11.1.5.1 Drawings shall be centered on 18" x 24" paper

11.1.6 Completed price breakdown of assets from Section 9.15 that reflects completed EEE.

11.1.7 Report of all OEM warranty periods per Section 12.2

11.1.8 Quality Control Program documentation per Section 15.1.1

12. WARRANTY

12.1 Supplier shall guarantee that the complete EEE will have no defects in materials and workmanship as well as warranted against water leakage per IEEE requirements for a period of five (5) years from date of shipment, except as limited or extended by the Original Equipment Manufacturer (OEM).

12.2 Supplier to provide report of all OEM components and equipment with their respective warranty periods

12.3 Manufacturer warranties shall pass through to Purchaser for 3rd party equipment, software, etc. (ex. SEL Relays, GE RTU).

12.4 Supplier to also adhere to Section 6.8.2

13. SHIPMENT

13.1 The delivery point will be: Minnesota Power [XXXXXX] Substation at the following address:

[XXXXXX] Substation
[Address]
[City, STATE Zip]

13.2 The EEE shall be able to be shipped via semi-tractor trailer method. The EEE may not be separated into two or more sections for shipment unless approved by Purchaser.

13.3 The Supplier shall prepare all equipment covered by this specification for shipment in such a manner as to protect it from damage in transit.

13.4 Any and all damage resulting from improper preparation or damage during transit shall be repaired or replaced at the Supplier's expense.

13.5 The EEE shall be wrapped such to protect it from dirt and debris during shipment.

13.6 The Supplier shall be responsible for delivery of the EEE to the substation, including shipping, placement on the Purchaser provided foundation, and performing all finishing work to make the unit ready for service.

14. INSTALLATION

14.1 The Supplier is responsible for the delivery and installation of the EEE and installation cost thereof. This is to include, but not limited to, cranes, rigging, and all associated materials and labor required to install the EEE on its foundation to include marking and chalking correct placement on the foundation and install any equipment removed from the EEE for shipment. The Supplier is solely responsible for providing the correct equipment for the terrain and ground conditions encountered at the site.

14.1.1 Anchor Bolts and Clips shall be provided by Supplier and included with the EEE delivery.

14.1.2 An initial site review can be scheduled with the Purchaser.

14.1.3 Installation cost is to be included in the quote as a separate line item.

14.2 The following shall be required five weeks before first date of shipment to avoid delays in critical path of assembly:

14.2.1 EEE facility lifting/crane/rigging plan shall be provided using a Purchaser foundation plan or drawing as background. The lift plan must include the following:

14.2.1.1 Location of truck/trailer

14.2.1.2 Location of crane

14.2.1.3 Final outrigger locations

14.2.1.4 Distance from center of crane to center of extended outrigger post

14.2.1.5 Dimensions from center of crane to centerline of outriggers, sides, front and back

14.2.2 Order of sections for final field assembly

15. QUALITY SYSTEM REQUIREMENTS

15.1 QUALITY ASSURANCE

15.1.1 Supplier shall have a Quality Control Program that follows the EEE from design through completion that shall be passed onto Purchaser with all instruction manuals and final record drawings.

15.2 VERIFICATION

15.2.1 The Purchaser shall have access to perform assessments, quality audits, or witness test activities during the manufacturing process and to review applicable records. Purchaser may designate an authorized agent to perform these activities. The authorized agent may be an employee of the Purchaser or an outside agency. When an outside agency is designated as an authorized agent for the Purchaser, such designation shall be in writing with a copy provided to the Supplier. Hereinafter, when the term "Purchaser's representative" is used, it may also mean the Purchaser or the authorized agent.

15.3 The following requirements apply for Purchaser's inspection at the Supplier's mill, factory, yard, warehouse, or sub tier Supplier's facilities:

15.3.1 The Purchaser shall have the right to access the Supplier's and sub tier supplier's work and related documents at any time during the manufacturing process without delaying the schedule. The Supplier shall provide, without cost, reasonable facilities including tools, personnel and instruments for demonstrating acceptability of the work.

15.3.2 If any items or articles are identified as not meeting the requirements of the specifications, the lot, or any faulty portion thereof, may be rejected. Before offering specified material or equipment for shipment, the Supplier shall inspect the material and equipment and eliminate any items that are defective or do not meet the requirements of the purchase order. The fact that equipment or materials have been previously inspected, tested, and accepted does not relieve the Supplier of responsibility in the case of later discovery of flaws or defects.

15.3.3 Materials or equipment purchased under this purchase order may be inspected at the specified receiving points and will either be accepted or rejected. Receipt inspection will include testing to determine compliance with the purchase specifications. Initial receipt inspection acceptance tests will be performed by the Purchaser at the Purchaser's expense. Items found to be defective may be returned to the Supplier for correction at the Supplier's expense, including shipping cost or the cost to correct and inspect the item will be charged to the Supplier.

15.3.4 Purchaser's review of drawings and other submittals will cover only general conformity of the data to the Specifications and Drawings, external connections, interfaces with equipment and materials furnished under separate specifications, and dimensions that affect plant arrangements. Purchaser's review does not include a thorough review of all dimensions, quantities, and details of the equipment, material, device, or item indicated or the accuracy of the information submitted. Review and comment by Purchaser of Supplier's Drawings or other submittals shall not relieve Supplier of its sole responsibility to meet the Completion Dates requirement of this Purchase Order and to supply Goods that conform to the requirements of this Purchase Order.

16. REVISION TABLE

Number	Date	By	Reviewed	Description
0	12/19/19	BAH	BAF	Reformat of existing EEE02CD Spec, Updated all sections, Changed section numbering, Added requirements

17. ATTACHMENTS, SPECIFICATIONS, AND DRAWINGS

17.1 The following attachment(s) will be referenced in the above specification. The Supplier is required to complete the attachment(s) and return the attachment(s) with the Supplier's proposal

Attachment
EEE02CD – Section 9.15 Bid Tab.xlsx

17.2 The following specifications are provided by the Purchaser, are referenced in this specification and are to be included in the EEE design.

Standard #	Standard Name
CA01PA	Flame Retardant Power & Control Cable
EEE02CD	Substation Electric Equipment Enclosure (EEE) Facilities and Structure
PN01PA	Control Panel
PN02PA	Distribution Panel – 125V DC Distribution Panel
PN03PA	Distribution Panel – 120/240 Volt 600 Volts or Less AC
SB01PA	Lead Storage Battery

17.3 The following drawings are referenced in the above specifications and include the panel elevations and associated lists of equipment that is to be provided by the Supplier and included in the EEE.

Drawing #	Drawing Name
[ME-XXXXX-XX SHX]	[Drawing Title]
[ME-XXXXX-XX SHX]	[Drawing Title]
[ME-XXXXX-XX SHX]	[Drawing Title]
[ME-XXXXX-XX SHX]	[Drawing Title]
[ME-XXXXX-XX SHX]	[Drawing Title]
[ME-XXXXX-XX SHX]	[Drawing Title]
[ME-XXXXX-XX SHX]	[Drawing Title]
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[ME-XXXXX-XX SHX]	[Drawing Title]
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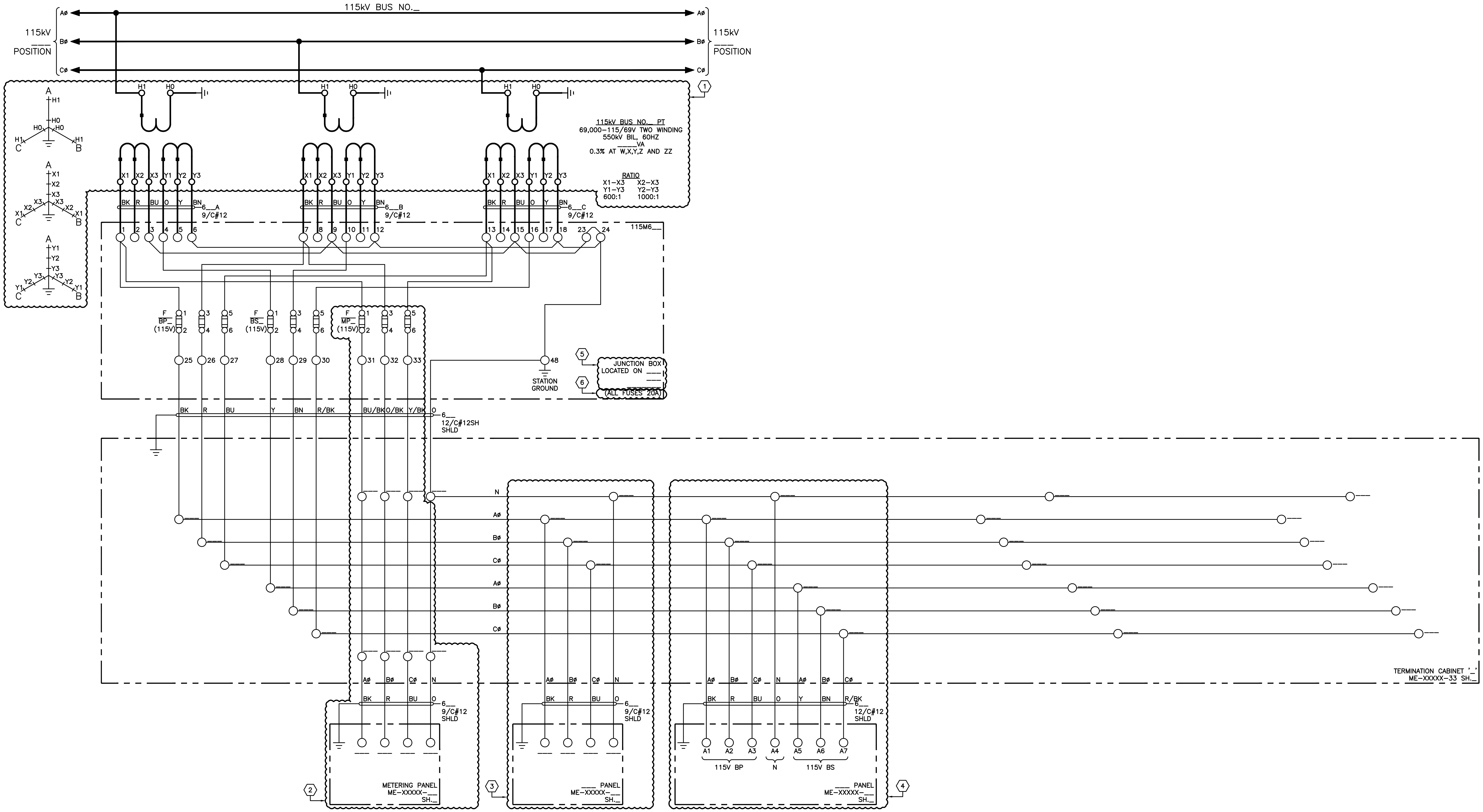

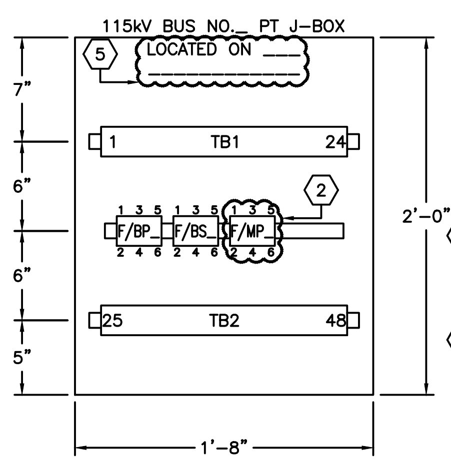

MARK	QTY	DEVICE	MFGR.	TYPE	CATALOG NO.	STORES	ITEM	REMARK	MTD.
J-BOX	1	JCT BOX 24" X 20" X 6" WITH INSIDE MOUNTING PLATE	STATES			6631200			
TB1,TB2	48	TERMINAL BLOCK	AB		1492-CD3	6676500			
	2	BLOCK END BARRIER	AB		1492-N16	6676501			
	4	BLOCK END ANCHOR	AB		1492-N23	6676503			
	2	MOUNTING RAIL – ALLEN BRADLEY	AB		1492-N22	6676502			
BP_, BS_, MP_	2 OR 3	3-POLE FUSE HOLDER	MERSEN	USCC3	ULTRASAFE	3084995			
	1	MOUNTING RAIL	PHOENIX	NS35/7,5	801733	6676507			
	6 OR 9	20A FUSES	MERSEN	20A	AMTR20	3000120			
	3 OR 4	FUSE ANCHORS	PHOENIX	E/NS 35N	800886	6676506			

KEYED DESIGN NOTES

POPULATE FUSE NAMES BASED ON STATION M&R DIAGRAM

1. UPDATE WITH VENDOR SCHEMATIC PRIOR TO ISSUING PRINT.
2. FOR 115kV METERING PANELS. OMIT IF NO 115kV METERING APPLICATIONS AT STATION.
3. FOR DFR AND 115kV BREAKER CONTROL PANELS. ADD ADDITIONAL POSITIONS OR REMOVE BASED ON STATION CONFIGURATION.
4. FOR 115kV LINE, BUS, AND CAPACITOR BANK PANELS. ADD ADDITIONAL POSITIONS OR REMOVE BASED ON STATION CONFIGURATION.
5. POPULATE WITH PHYSICAL LOCATION OF J-BOX IN THE YARD.
6. SIZE FUSES IN COORDINATION WITH PT'S THERMAL RATING AND TAP VOLTAGES. DIVIDE PT THERMAL RATING BY VOLTAGE AND USE NEXT LOWEST STANDARD FUSE SIZE. IF CABLE AMPACITY OF CIRCUIT IS LOWER THAN THIS VALUE, SIZE FUSE FOR CABLE AMPACITY. SEE STANDARD 410.3 FOR DETAILS.

REMOVE ALL KEYED DESIGN NOTES.
DELETE THE "Z-DESIGN (DELETE)" LAYER.

UNIQUE CHARACTER IDENTIFIERS

REPLACE XXXXX WITH SUBSTATION PROJECT NUMBER

REMOVE ALL UNIQUE CHARACTER IDENTIFIERS NOTES.

NO.	DATE	REVISION DESCRIPTION	BY	APPROVED	NO.	DATE	REVISION DESCRIPTION	BY	APPROVED
A	03-08-23	MP STANDARDS – FINAL ISSUE	BSN/BV	PJK/BV	.	.	.	.	.
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DRAWN BY	.
APPROVED	.
DATE	.
SCALE	.

minnesota power
AN ALLETE COMPANY

STANDARD
115kV BUS NO._ POTENTIALS
AC SCHEMATIC & WIRING DIAGRAM

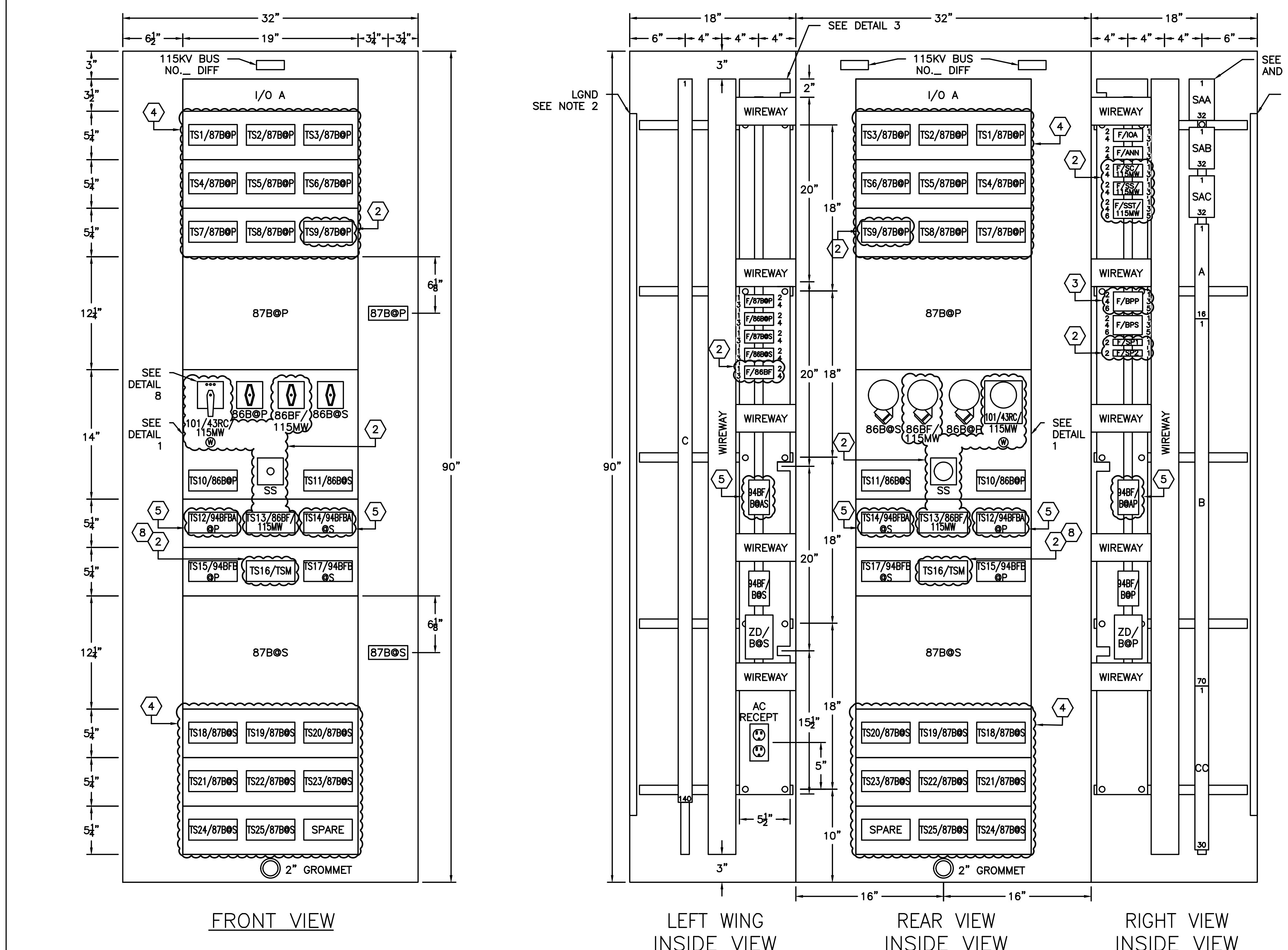
SHEET 1 REV. A

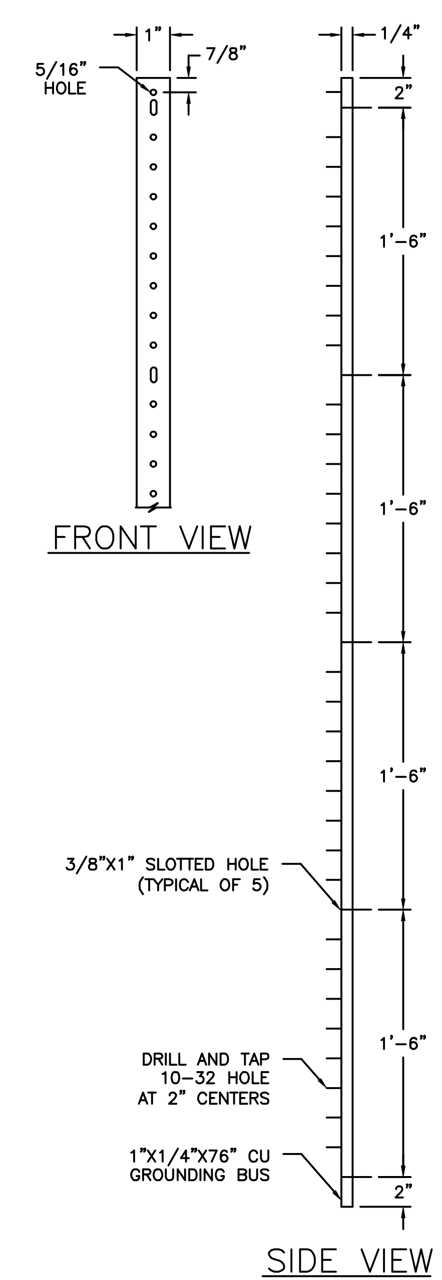
ME-35702-03

CADD DRAWING – FOR REPRODUCTION ONLY

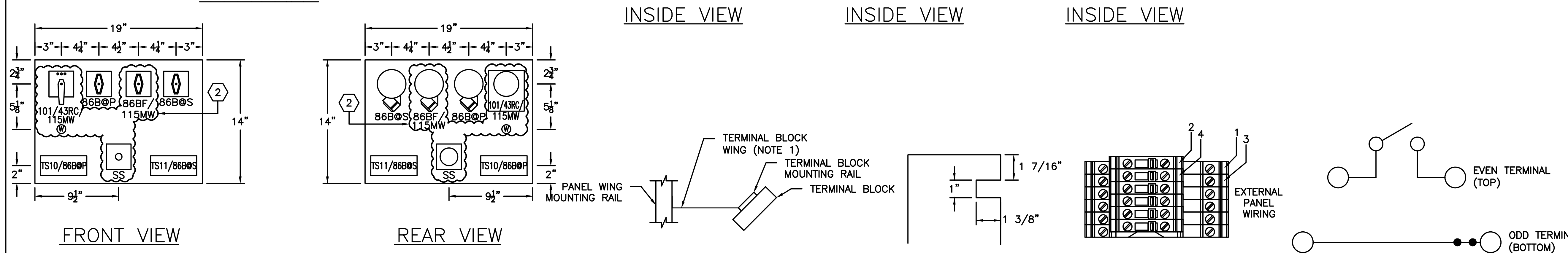
MICROFILMED	CODE		
/ /	.	3200	3503

ImageSite: . .





DETAIL 7
GROUND RAIL FABRICATION
(NOT TO SCALE)



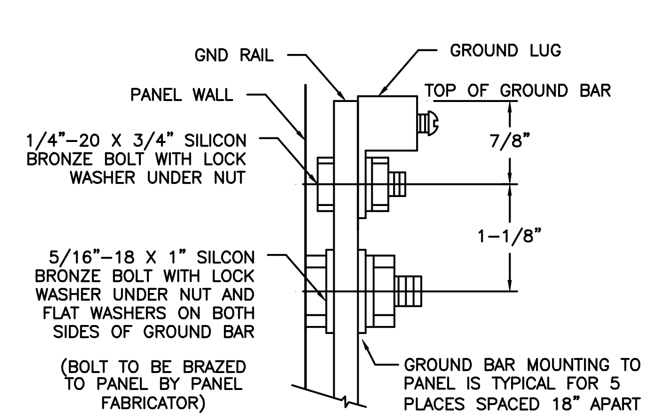
DETAIL 1
CONTROL SWITCH PLATE
SCALE: 1 1/2" = 1'-0"

DETAIL 2
TERMINAL BLOCK MOUNTING
(NOT TO SCALE)

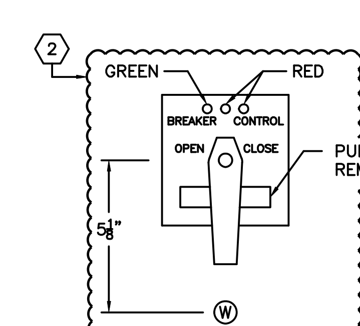
DETAIL 3
FUSE PLATE INDENTS
(NOT TO SCALE)

DETAIL 4
KNIFE DISCONNECT INSTALLATION DETAIL
(NOT TO SCALE)

DETAIL 5
KNIFE DISCONNECT CIRCUIT DIAGRAM
(NOT TO SCALE)



DETAIL 6
PANEL GROUNDING LUG
(NOT TO SCALE)



DETAIL 8
101/43RC CONTROL SWITCH NAMEPLATE
(NOT TO SCALE)

MARK	QTY	DEVICE	MFGR.	TYPE	CATALOG NO.	RANGE	STORES	REMARKS
87B@P, 87B@S	2	BUS PROTECTION RELAY	SEL	487B	~~0487B1X6X52XB0XEH8XXXXX OR~~ 0487B1X6X52XB0XEH8PXXXX			
I/O A	1	ORION I/O	NOVATECH		I/O-SX-EP-411X-AD-WR 42-44-98			
	8	TEST SWITCH RACK ASSEMBLY	ABB	FT-19	FR3G000000000		6602412	
TS1/87B@P, TS2/87B@P, TS3/87B@P, TS4/87B@P, TS5/87B@P, TS6/87B@P, TS7/87B@P, TS16/TSM, TS18/87B@S, TS19/87B@S, TS20/87B@S, TS21/87B@S, TS22/87B@S, TS23/87B@S, TS24/87B@S	14 OR 15	TEST SWITCH - 6C - 4P RACK MOUNTED	ABB	FT-19	R129A514G01		6602403	
TS8/87B@P, TS9/87B@P, TS12/94BFA@P, TS13/86BF, TS14/94BFA@S, TS15/94BFB@P, TS17/94BFB@S, TS25/87B@S	6 OR 8	TEST SWITCH - 10P RACK MOUNTED	ABB	FT-19	R129A501G01		6602404	
TS10/86B@P, TS11/86B@S	2	TEST SWITCH - 10P RACK MOUNTED	ABB	FT-19	R129A501G01		6602404	
86B@P, 86B@S	2	BUS DIFF LOR W/ENGRAVING CODE 17C-2L22	ELECTRO	SERIES 24	7806D		6658201	
	2	ORANGE HANDLE	ELECTRO	02000-11A-2				FOR 86B@
86BF	1	BKR FAIL LOR W/ENGRAVING CODE 17C-2L22	ELECTRO	SERIES 24	7806D		6658201	
	1	BLUE HANDLE	ELECTRO	02000-11A-7				FOR 86BF
94BFB@P, 94BFB@AP, 94BFB@S, 94BFB@AS	2 OR 4	CONTROL RELAY	SQD	XUDO	8501XUDO80V63		6650600	
MOV	2 OR 4	METAL OXIDE VARISTOR	LITTLE FUSE		V20E150P			
SS	1	SYNCH SWITCH W/ENGRAVING CODE 11D-2S17	ELECTRO	SERIES 24	2424E		6650755	
	1	SYNCH SWITCH OVAL REMOVABLE HANDLE	ELECTRO		002013-3			
101/43RC/115MW	1	BREAKER CONTROL SWITCH W/ENGRAVING CODE 123B-2B36A	ELECTRO	SERIES 24	88PDGRRX203FCLA		6650777	
W	1	WHITE ILLUMINATING LIGHT	GE	ET-16 LED	116B6708G43W73W5		6646003	
F/SP1, F/SP2, F/BPP	3	1-POLE FUSE HOLDER	MERSEN	ULTRASAFE	USCC1		3084985	
F/87B@P, F/87B@S, F/86B@P, F/86B@S F/IOA, F/ANN, F/SC/115MW, F/SS/115MW, F/86BF	6 OR 9	2-POLE FUSE HOLDER	MERSEN	ULTRASAFE	USCC2		3084990	
F/BPS, F/BPP, F/SST/115MW	2 OR 3	3-POLE FUSE HOLDER	MERSEN	ULTRASAFE	USCC3		3084995	
	11 OR 17	FUSE ANCHORS	PHOENIX	E/NS 35N	800886		6676506	FOR DIN-MOUNTED DEVICES
	14 OR 20	10A FUSES	MERSEN	10A	ATMR10		3000110	
	2	6A FUSES	MERSEN	6A	ATMR6		3000106	
	2 OR 7	3A FUSES	MERSEN	3A	ATMR3		3000103	
	2	1A FUSE	MERSEN	1A	ATMR1		3000101	
SAA, SAB, SAC	48	KNIFE DISCONNECT S-TERMINAL BLOCKS	PHOENIX	UTTB-4-MT	3044775		6676505	
	3	S-BLOCK END COVER	PHOENIX	D-UTTB 2.5/4	3047293			
	4	S-BLOCK END CLAMP	PHOENIX	CLIPFIX 35-5	3022276			
	3	TERMINAL STRIP MARKER CARRIER	PHOENIX	KLM 3	811969			
	1	MOUNTING RAIL - PHOENIX	PHOENIX	NS35/7.5	0801733		6676507	
	3	TERMINAL BLOCK MARKER	PHOENIX	ZB 6, QR	1051029:0001			LABELED 1-10
	3	TERMINAL BLOCK MARKER	PHOENIX	ZB 6, QR	1051029:0011			LABELED 11-20
	3	TERMINAL BLOCK MARKER	PHOENIX	ZB 6, QR	1051029:0021			LABELED 21-30
	3	TERMINAL BLOCK MARKER	PHOENIX	ZB 6, QR	1051029:0031			LABELED 31-40
A, B, C, CC	246	A-B-C TERMINAL BLOCKS	AB		1492-CD3		6676500	
	4	A-B-C BLOCK END BARRIER	AB		1492-N16		6676501	
	8	A-B-C BLOCK END ANCHOR	AB		1492-N23		6676503	
	4	MOUNTING RAIL - ALLEN BRADLEY	AB		1492-N22		6676502	
	2	ALUMINUM MOUNTING CHANNEL	POWER STRUT		PS700J-10-AL			
LGND, RGND	2	1" X 1/4" X 76" COPPER GROUNDING RAIL					4596000	
	2	GROUND LUG	BURNDY		KA28			
WIREWAY	4	3" X 3" WIREWAY	PANDUIT		F3X3LG6		6630803	
	4	3" WIREWAY COVER	PANDUIT		C3LG6			
	1	14"X19" CONTROL SWITCH PLATE						
2" GROMMET	1	SNAP BUSHING FITS 2" HOLE	HEYCO	2400	2400			
AC RECEPT	1	120VAC 20A DUPLEX RECEPTACLE	HUBBELL	HBL5362				
	1	HANDY BOX	APPLETON	180-1/2				
	1	RECEPTACLE COVER	APPLETON	180W				
	3	COAXIAL ADAPTERS, BNC (M-F-F)	LCOM		BA840		9401741	
	1	BNC FEMALE TO 2-WIRE BREAKOUT	LCOM		BC55			
TERM RESISTOR	1	BNC TERMINAL, 50-OHM TO RG-58 COAXIAL	AMPHENOL		RF 00-46650-51RFX			
ZD/B@P, ZD/B@S	2	ZENER DIODE	ABB	TRB-2	408C003G01		6650402	

NOTES:

1. VENDOR SHALL MOUNT TERMINAL BLOCKS AT 45° ANGLE FROM WING PER DETAIL 2.
2. GROUND ALL CT'S AND CABLE SHIELDS ON GROUND RAIL.

KEYED DESIGN NOTES

1. VERIFY RELAY CONFIGURATION AND PART NUMBERS WITH MP RELAY ENGINEERING PRIOR TO ISSUING PRINT.
2. FOR 115MW TIE BREAKER USE DITHERED OPTION FOR 115MW BREAKER CONTROL OR RING BUS CONFIGURATIONS THAT RECEIVES CONTROL FROM THIS PANEL. OMIT UNLESS REQUIRED.
3. CHANGE BPP FUSE TO A 1-POLE FUSE HOLDER AND ONE 10A FUSE IF 115KV TIE BREAKER CONTROL IS INSTALLED IN THIS PANEL.
4. ADJUST NUMBER OF TEST SWITCHES BASED ON BUS CONFIGURATION.
5. ADD 94BFB@A RELAY IF THERE ARE NOT ENOUGH AVAILABLE CONTACTS ON 94BFB@ FOR ALL BF TRIPS.
6. FOR END OF IRIG CHAIN; OMIT IF IRIG CHAIN DOES NOT END AT THIS PANEL.
7. ADJUST END CLAMPS BASED ON PANEL'S DINRAIL-MOUNTED DEVICE CONFIGUARTIONS. INCLUDE ONE CLAMP ABOVE AND BELOW EACH FUSE HOLDER.
8. OMIT UNLESS REQUIRED FOR DFR CT CONNECTIONS FROM THIS PANEL.

REMOVE ALL KEYED DESIGN NOTES. CHANGE ALL ITEMS SHOWN IN GREY TO CORRECT LAYER IF USED IN THE DESIGN. DELETE THE "Z-DESIGN (DELETE)" LAYER.

UNIQUE CHARACTER IDENTIFIERS

REPLACE 115MW WITH TIE BREAKER NAME IF RING CONFIGURED

REPLACE @ WITH BUS NUMBER

REMOVE ALL UNIQUE CHARACTER IDENTIFIERS NOTES.

NO.	DATE	REVISION DESCRIPTION	BY	APPROVED	NO.	DATE	REVISION DESCRIPTION	BY	APPROVED
A	08-25-22	MP STANDARDS - FINAL ISSUE	PJK/BV	GTJ/BV	.	.	.	.	.
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DRAWN BY .
APPROVED
DATE .
SCALE 1 1/2" = 1'-0"

minnesota power
AN ALLETE COMPANY

115kV STANDARD
115kV BUS DIFF PANEL
ELEVATION & BILL OF MATERIALS

SHEET 1 REV. A
ME-35702-04

CADD DRAWING - FOR REPRODUCTION ONLY

MICROFILMED / /
CODE . 3200 3508

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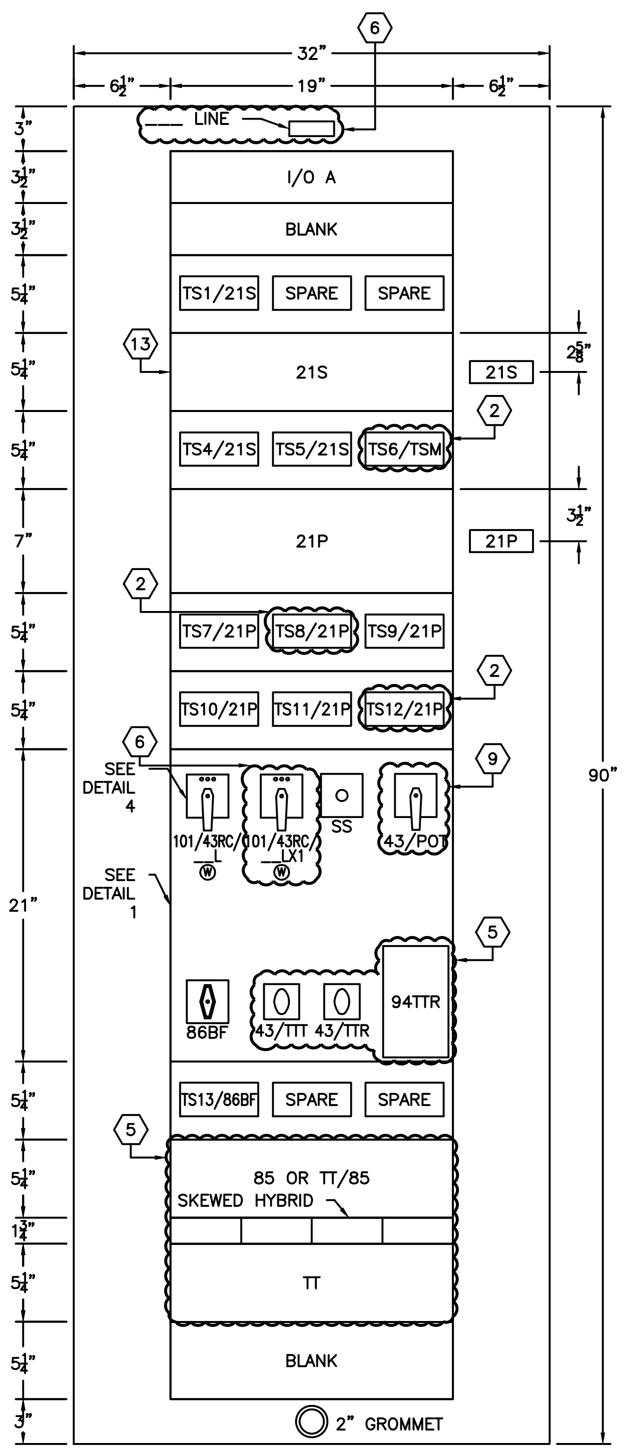
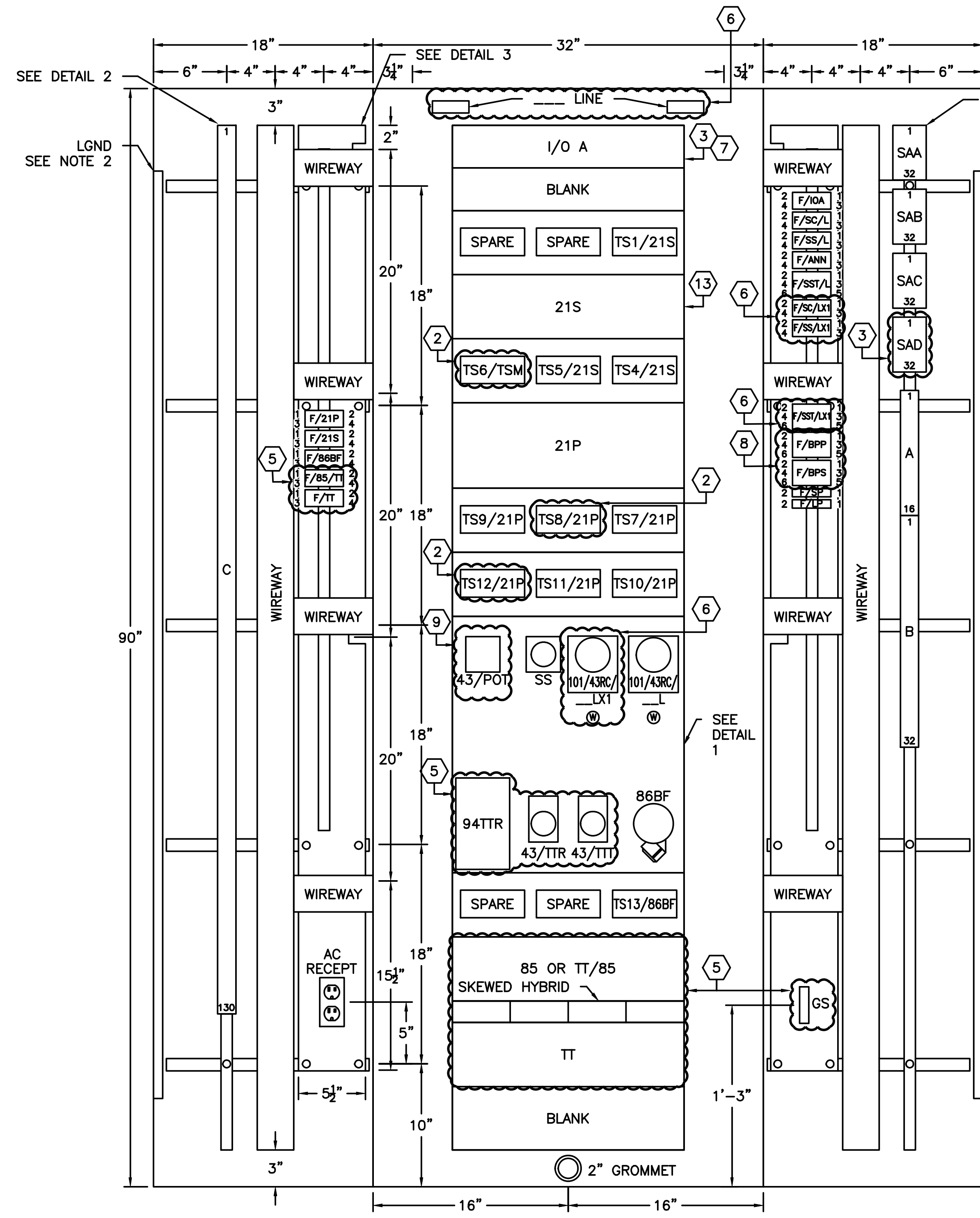


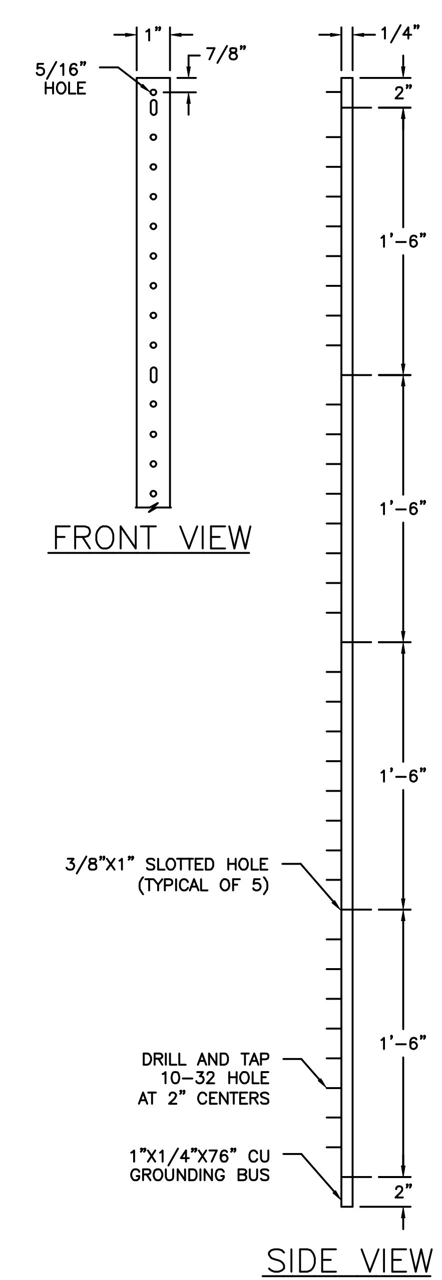
FRONT VIEW



LEFT WING INSIDE VIEW

REAR VIEW INSIDE VIEW

RIGHT VIEW INSIDE VIEW

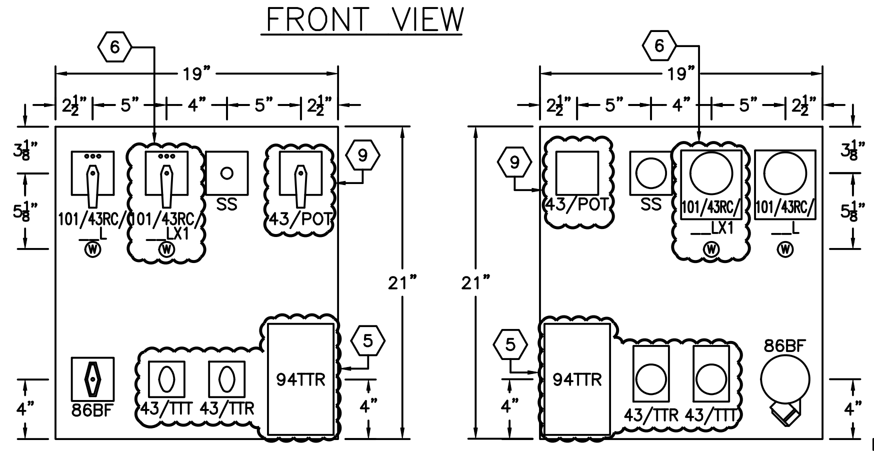


FRONT VIEW

SIDE VIEW

DETAIL 7

GROUND RAIL FABRICATION (NOT TO SCALE)

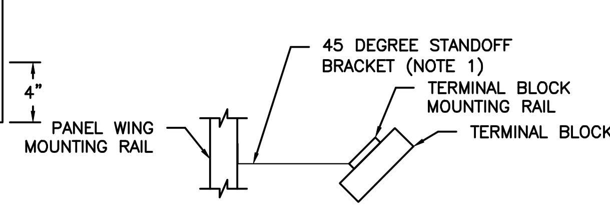


FRONT VIEW

REAR VIEW

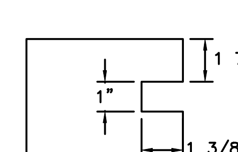
DETAIL 1

CONTROL SWITCH PLATE
SCALE: 1 1/2" = 1'-0"



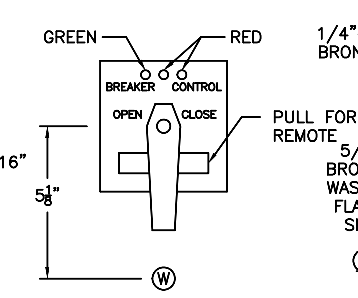
DETAIL 2

TERMINAL BLOCK MOUNTING (NOT TO SCALE)



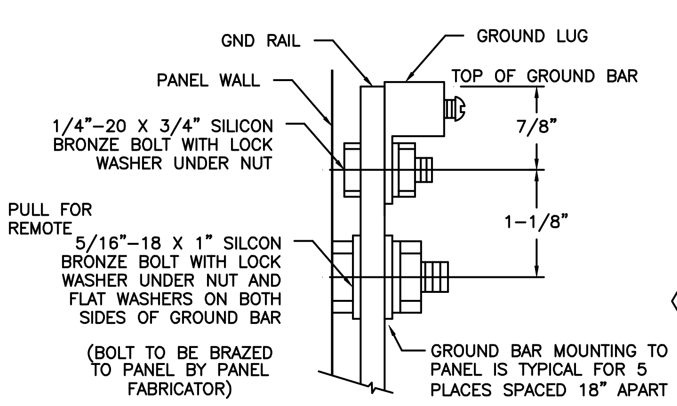
DETAIL 3

FUSE PLATE INDENTS (NOT TO SCALE)



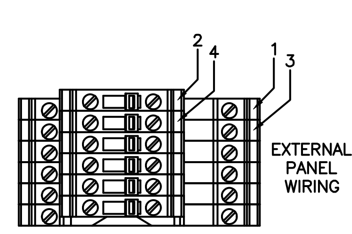
DETAIL 4

101/43RC CONTROL SWITCH NAMEPLATE (NOT TO SCALE)



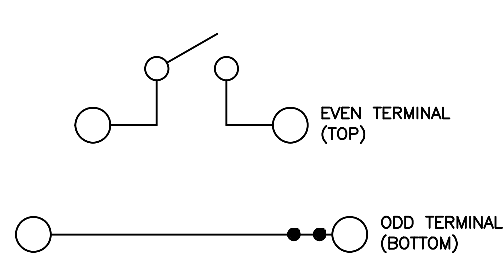
DETAIL 8

PANEL GROUNDING LUG (NOT TO SCALE)



DETAIL 5

KNIFE DISCONNECT INSTALLATION DETAIL (NOT TO SCALE)



DETAIL 6

KNIFE DISCONNECT CIRCUIT DIAGRAM (NOT TO SCALE)

MARK	QTY	DEVICE	MFGR.	TYPE	CATALOG NO.	RANGE	STORES	REMARKS
21P	1	MICRO PROCESSOR DISTANCE RELAY	SEL	421-4	04214615XB0X4H324XXXX		6659029	
21S	1	MICRO PROCESSOR DISTANCE RELAY	SEL	311C	0311C10HH4E54X1 (2RU) OR 0311C11HH4E5421 (3RU)		6659017 OR NONE	
CONV	1	SINGLE MODE FIBER-OPTIC TRANSCEIVER/MODEM	SEL	2829/ 2830/ 2831	2829M/ 2830M/ 2831M			
I/O A	1	ORION I/O	NOVATECH		I/O-SX-EP-411X-AD-WR 42-44-98			
	3 OR 5	TEST SWITCH RACK ASSEMBLY	ABB	FT-19	FR3G000000000		6602412	
TS4/21S, TS6/TSM, TS9/21P, TS8/21P	3 OR 4	TEST SWITCH - 6C - 4P RACK MOUNTED	ABB	FT-19	R129A514G01		6602403	
TS1/21S, TS5/21S, TS7/21P, TS10/21P, TS11/21P, TS12/21P, TS13/86BF	6 OR 7	TEST SWITCH - 10P RACK MOUNTED	ABB	FT-19	R129A501G01		6602404	
W	1 OR 2	WHITE ILLUMINATING LIGHT	GE	ET-16 LED	116B6708G43W73W5		6646003	
SS	1	SYNCH SWITCH W/ ENGRAVING CODE: 11D-2S17	ELECTRO	SERIES 24	2424E		6650755	
	1	SYNCH SWITCH OVAL REMOVABLE HANDLE	ELECTRO	002013-3				
101/43RC/__L 101/43RC/__LX1	1 OR 2	BREAKER CONTROL SWITCH W/ ENGRAVING CODE: 123B-2B36A	ELECTRO	SERIES 24	88PDGRRX203FCLA		6650777	
86BF	1	BKR FAIL LOR W/ ENGRAVING CODE: 17C-2L22	ELECTRO	SERIES 24	7806D		6658201	
	1	BLUE HANDLE	ELECTRO	02000-11A-7				FOR 86BF
43/TTT, 43/TTR	1, 2	SELECTOR SWITCH W/ OPERATE & RESET COILS ENGRAVING CODES: 43/TTT: 031D-2T12AD 43/TTR: 031D-2T12AB 43/TTT2: 031D-2T12AE 43/TTR2: 031D-2T12AC	ELECTRO	SERIES 31 LSR	9303DD OR 9306DD		6650751 OR NONE	
43/POT	1	POTENTIAL TRANSFER SWITCH ENGRAVING CODE: 010D-2P22BA OR 010D-2P22AZ	ELECTRO	SERIES 24	24203B		6650757	
F/LP, F/SP	2	1-POLE FUSE HOLDER	MERSEN	ULTRASAFE	USCC1		3084985	
F/21P, F/21S, F/SC/L, F/SS/L, F/86BF, F/IO, F/ANN, F/85, OR F/TT/85, F/TT, F/SC/LX1, F/SS/LX1	8 OR 9, 11	2-POLE FUSE HOLDER	MERSEN	ULTRASAFE	USCC2		3084990	
F/BPP, F/BPS, F/SST/L, F/SST/LX1	3 OR 4	3-POLE FUSE HOLDER	MERSEN	ULTRASAFE	USCC3		3084995	
	15 OR 16, 17, 20	FUSE ANCHORS	PHOENIX	E/NS 35N	800886		6676506	FOR DIN-MOUNTED DEVICES
	16, 14 OR 16, 18	10A FUSES	MERSEN	10A	ATMR10		3000110	
	2 OR 4	6A FUSES	MERSEN	6A	ATMR6		3000106	
	7 OR 12	3A FUSES	MERSEN	3A	ATMR3		3000103	
	2	1A FUSE	MERSEN	1A	ATMR1		3000101	
SAA, SAB, SAC, SAD	48 OR 64	KNIFE DISCONNECT S-TERMINAL BLOCKS	PHOENIX	UTTB-4-MT	3044775		6676505	
	3 OR 4	S-BLOCK END COVER	PHOENIX	D-UTTB 2.5/4	3047293			
	4 OR 5	S-BLOCK END CLAMP	PHOENIX	CLIPFIX 35-5	3022276			
	3 OR 4	TERMINAL STRIP MARKER CARRIER	PHOENIX	KLM 3	811969			
	1	MOUNTING RAIL - PHOENIX	PHOENIX	NS35/7.5	0801733		6676507	
	3 OR 4	TERMINAL BLOCK MARKER	PHOENIX	ZB 6, QR	1051029:0001			LABELED 1-10
	3 OR 4	TERMINAL BLOCK MARKER	PHOENIX	ZB 6, QR	1051029:0011			LABELED 11-20
	3 OR 4	TERMINAL BLOCK MARKER	PHOENIX	ZB 6, QR	1051029:0021			LABELED 21-30
	3 OR 4	TERMINAL BLOCK MARKER	PHOENIX	ZB 6, QR	1051029:0031			LABELED 31-40
A, B, C	178	A-B-C TERMINAL BLOCKS	AB		1492-CD3		6676500	
	3	A-B-C BLOCK END BARRIER	AB		1492-N16		6676501	
	6	A-B-C BLOCK END ANCHOR	AB		1492-N23		6676503	
	4	MOUNTING RAIL - ALLEN BRADLEY	AB		1492-N22		6676502	
	2	ALUMINUM MOUNTING CHANNEL	POWER STRUT		PS700J-10-AL			
LGND, RGND	2	1" X 1/4" X 76" COPPER GROUNDING RAIL					4596000	PER DETAIL 7
	2	GROUND LUG	BURNDY		KA28			
WIREWAY	4	3" X 3" WIREWAY	PANDUIT		F3X3LG6		6630803	
	4	3" WIREWAY COVER	PANDUIT		C3LG6			
	1	21" 3/4"x19" CONTROL SWITCH PLATE						
BLANK	1	3 1/2"x19" BLANK PANEL						
BLANK	1	5 1/4"x19" BLANK PANEL						
2" GROMMET	1	SNAP BUSHING FITS 2" HOLE	HEYCO		2400			
AC RECEPT	1	120VAC 20A DUPLEX RECEPTACLE	HUBBELL		HBL5362			
	1	HANDY BOX	APPLETON		180-1/2			
	1	RECEPTACLE COVER	APPLETON		180W			
LCOM 840	3 OR 4, 5	COAXIAL ADAPTERS, BNC (M-F-F)	LCOM		BA840		9401741	
LCOM BC55	1	BNC FEMALE TO 2-WIRE BREAKOUT	LCOM		BC55			
GS	1	GROUND SWITCH	STATES	SJK	20K01-B		6943300	
85 OR 85/TT, TT	1 OR 2	ON/OFF CARRIER/FREQUENCY SHIFT KEY CARRIER	PULSAR	UPLC II	US1NEM7NFSX	125V DC	6659052	
	1	1RU CHASSIS FLUSH MOUNTING	PULSAR	1088-780			6650699	
SKEWED HYBRID	1	SKEWED HYBRID	PULSAR		CH20-SKWMN-001		6650705	
BALANCED HYBRID	1	RESISTIVE HYBRID	PULSAR		CH20-BALMN-001		6650700	
94/TTR	1	LATCHING RELAY	ABB	RXMVB4	RK251402-AP			
	1	RELAY CASE (MOUNTING KIT ASSEMBLY TO INCLUDE CONTACT SOCKETS, 10A, P/N:IMRK002136-A)	ABB	RHGX4	AI56190001-A		6676402	
TERM RESISTOR	1	BNC TERMINAL, 50-OHM TO RG-58 COAXIAL	AMPHENOL		RF 00-46650-51RFX			

NOTES:

1. VENDOR SHALL MOUNT TERMINAL BLOCKS AT 45° ANGLE FROM WING PER DETAIL 2
2. GROUND ALL CT'S AND CABLE SHIELDS ON GROUND RAIL.

KEYED DESIGN NOTES

1. VERIFY RELAY CONFIGURATION AND PART NUMBERS PRIOR TO ISSUING PRINT.
2. MODIFY TEST SWITCH TYPES & NAME TO SUIT CONTROL REQUIREMENTS.
3. INSTALL 1-SA BLOCK PER I/O CARD INSTALLED.
4. FIBER TRANSCIEVER CHOSEN BY DISTANCE. VERIFY WITH MP RELAYING & COMMUNICATIONS ENGINEERING.
5. VERIFY COMMUNICATION REQUIREMENTS WITH ENGINEERING. DELETE UNNECESSARY EQUIPMENT.
6. FILL IN BLANKS WITH INFORMATION FROM ENGINEERING M&R. REMOVE MOD CONTROL SWITCH & FUSES IF NOT REQUIRED.
7. LEAVE AT LEAST 1RU BLANK BETWEEN I/O AND OTHER RACK EQUIPMENT FOR PANEL SIS WIRING.
8. SET UP FOR RADIAL BUS. IF RING-BUS CONNECTED, CHANGE FUSES FROM "BPP" AND "BPS" TO "LPP" AND "LSS".
9. OMIT IF PARALLEL POTENTIAL NOT PRESENT ON BUS(ES) LINE IS CONNECTED TO. 2P22BA FOR WHEN BUS 2 IS NORMAL. 2P22ZA FOR WHEN BUS 1 IS NORMAL.
10. FOR END OF IRIG CHAIN; OMIT IF IRIG CHAIN DOES NOT END AT THIS PANEL.
11. ADJUST END CLAMPS BASED ON PANEL'S DINRAIL-MOUNTED DEVICE CONFIGURATIONS. INCLUDE ONE CLAMP ABOVE AND BELOW EACH FUSE HOLDER.
12. UPDATE 43/TTT AND 43/TTR SWITCHES TO 6 DECKS IF RING CONFIGURED.
13. USE 3RU SIZE FOR RING POSITION SEL-311C; USE 2RU SIZE FOR RADIAL POSITION.

REMOVE ALL KEYED DESIGN NOTES. CHANGE ALL ITEMS SHOWN IN GREY TO CORRECT LAYER IF USED IN THE DESIGN. DELETE THE "Z-DESIGN (DELETE)" LAYER.

NO.	DATE	REVISION DESCRIPTION	BY	APPROVED	NO.	DATE	REVISION DESCRIPTION	BY	APPROVED
A	08-25-22	MP STANDARDS - FINAL ISSUE	PJK/BV	GTJ/BV	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.
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DRAWN BY .
APPROVED .
DATE .
SCALE 1 1/2" = 1'-0"

minnesota power
AN ALLETE COMPANY

115kV STANDARD
LINE PANEL (421-4/311C)
ELEVATION & BILL OF MATERIALS

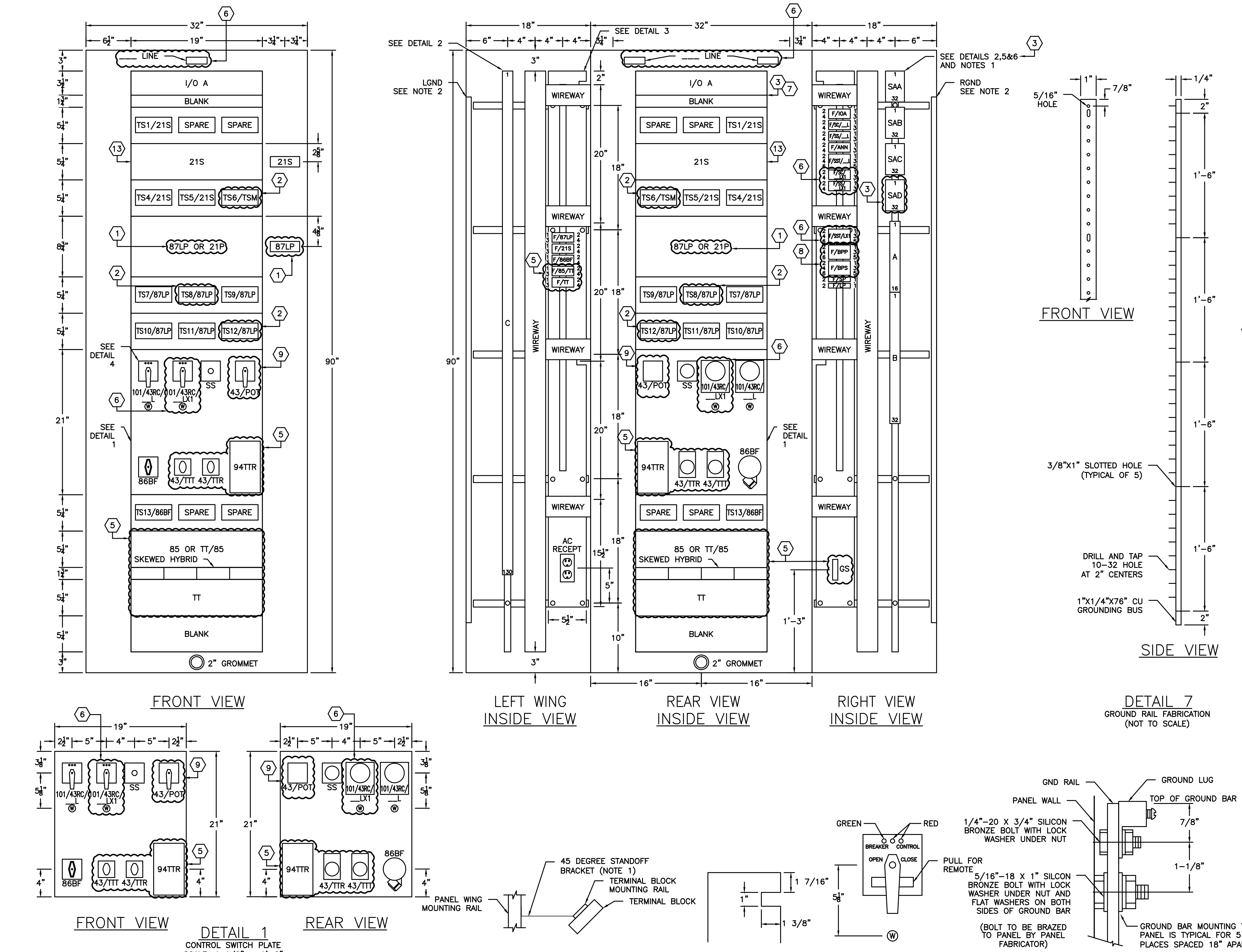
SHEET 1 REV. A

ME-35702-08

CADD DRAWING - FOR REPRODUCTION ONLY

MICROFILMED	CODE		
/ /	.	3200	3508

ImageSite: .



FRONT VIEW

LEFT WING INSIDE VIEW

REAR VIEW INSIDE VIEW

RIGHT VIEW INSIDE VIEW

FRONT VIEW

SIDE VIEW

DETAIL 7
GROUND RAIL FABRICATION
(NOT TO SCALE)

FRONT VIEW

REAR VIEW

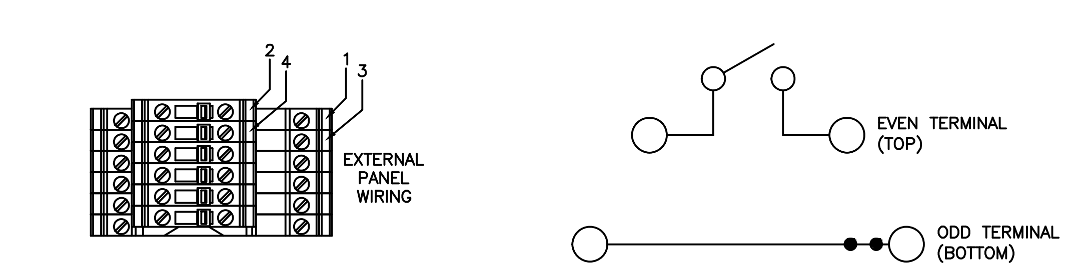
DETAIL 1
CONTROL SWITCH PLATE
SCALE: 1 1/2" = 1'-0"

DETAIL 2
TERMINAL BLOCK MOUNTING
(NOT TO SCALE)

DETAIL 3
FUSE PLATE INDENTS
(NOT TO SCALE)

DETAIL 4
101/43RC CONTROL SWITCH NAMEPLATE
(NOT TO SCALE)

DETAIL 8
PANEL GROUNDING LUG
(NOT TO SCALE)



DETAIL 5
KNIFE DISCONNECT
INSTALLATION DETAIL
(NOT TO SCALE)

DETAIL 6
KNIFE DISCONNECT
CIRCUIT DIAGRAM
(NOT TO SCALE)

MARK	QTY	DEVICE	MFGR.	TYPE	CATALOG NO.	RANGE	STORES	REMARKS
87LP	1	MICRO PROCESSOR DISTANCE RELAY	SEL	411L	0411L1X6X5B8D0XH52424XX			
21S	1	MICRO PROCESSOR DISTANCE RELAY	SEL	311C	0311C10HH4E54X1 (2RU) OR 0311C11HH4E5421 (3RU)		6659017 OR NONE	
CONV	1	SINGLE MODE FIBER-OPTIC TRANSCEIVER/MODEM	SEL	2829/ 2830/ 2831	2829M/ 2830M/ 2831M			
I/O A	1	ORION I/O	NOVATECH		I/O-SX-2E-411X-AD-WR 42-44-98			
	5	TEST SWITCH RACK ASSEMBLY	ABB	FT-19	FR3G000000000		6602412	
TS4/21S, TS6/TSM, TS9/87LP, TS8/87LP	3 OR 4	TEST SWITCH - 6C - 4P RACK MOUNTED	ABB	FT-19	R129A514G01		6602403	
TS1/21S, TS5/21S, TS7/87LP, TS10/87LP, TS11/87LP, TS12/87LP, TS13/86BF	6 OR 7	TEST SWITCH - 10P RACK MOUNTED	ABB	FT-19	R129A501G01		6602404	
W	1 OR 2	WHITE ILLUMINATING LIGHT	GE	ET-16 LED	116B6708G43W73W5		6646003	
SS	1	SYNCH SWITCH W/ ENGRAVING CODE: 11D-2S17	ELECTRO	SERIES 24	2424E		6650755	
	1	SYNCH SWITCH OVAL REMOVABLE HANDLE	ELECTRO	002013-3				
101/43RC/__L 101/43RC/__LX1	1 OR 2	BREAKER CONTROL SWITCH W/ ENGRAVING CODE: 123B-2B36A	ELECTRO	SERIES 24	88PDGRRX203FCLA		6650777	
86BF	1	BKR FAIL LOR W/ ENGRAVING CODE: 17C-2L22	ELECTRO	SERIES 24	7806D		6658201	
	1	BLUE HANDLE	ELECTRO	02000-11A-2				FOR 86BF
43/TTT, 43/TTR	1, 2	SELECTOR SWITCH W/ OPERATE & RESET COILS ENGRAVING CODES: 43/TTT: 031D-2T12AD 43/TTR: 031D-2T12AB 43/TTT2: 031D-2T12AE 43/TTR2: 031D-2T12AC	ELECTRO	SERIES 31 LSR	9303DD OR 9306DD		6650751 OR NONE	
43/POT	1	POTENTIAL TRANSFER SWITCH ENGRAVING CODE: 010D-2P22BA OR 010D-2P22AZ	ELECTRO	SERIES 24	24203B		6650757	
F/LP, F/SP	2	1-POLE FUSE HOLDER	MERSEN	ULTRASAFE	USCC1		3084985	
F/87LP, F/21S, F/SC/L, F/SS/L, F/86BF, F/IO, F/ANN, F/85, OR F/TT/85, F/TT, F/SC/LX1, F/SS/LX1	8 OR 9, 11	2-POLE FUSE HOLDER	MERSEN	ULTRASAFE	USCC2		3084990	
F/BPP, F/BPS F/SST/L, F/SST/LX1	3 OR 4	3-POLE FUSE HOLDER	MERSEN	ULTRASAFE	USCC3		3084995	
	15 OR 16, 17, 20	FUSE ANCHORS	PHOENIX	E/NS 35N	800886		6676506	FOR DIN-MOUNTED DEVICES
	16, 14 OR 16, 18	10A FUSES	MERSEN	10A	ATMR10		3000110	
	2 OR 4	6A FUSES	MERSEN	6A	ATMR6		3000106	
	7 OR 12	3A FUSES	MERSEN	3A	ATMR3		3000103	
	2	1A FUSE	MERSEN	1A	ATMR1		3000101	
SAA, SAB, SAC, SAD	48 OR 64	KNIFE DISCONNECT S-TERMINAL BLOCKS	PHOENIX	UTTB-4-MT	3044775		6676505	
	3 OR 4	S-BLOCK END COVER	PHOENIX	D-UTTB 2,5/4	3047293			
	4 OR 5	S-BLOCK END CLAMP	PHOENIX	CLIPFIX 35-5	3022276			
	3 OR 4	TERMINAL STRIP MARKER CARRIER	PHOENIX	KLM 3	811969			
	1	MOUNTING RAIL - PHOENIX	PHOENIX	NS35/7,5	0801733		6676507	
	3 OR 4	TERMINAL BLOCK MARKER	PHOENIX	ZB 6, QR	1051029:0001			LABELED 1-10
	3 OR 4	TERMINAL BLOCK MARKER	PHOENIX	ZB 6, QR	1051029:0011			LABELED 11-20
	3 OR 4	TERMINAL BLOCK MARKER	PHOENIX	ZB 6, QR	1051029:0021			LABELED 21-30
	3 OR 4	TERMINAL BLOCK MARKER	PHOENIX	ZB 6, QR	1051029:0031			LABELED 31-40
A, B, C	178	A-B-C TERMINAL BLOCKS	AB		1492-CD3		6676500	
	3	A-B-C BLOCK END BARRIER	AB		1492-N16		6676501	
	6	A-B-C BLOCK END ANCHOR	AB		1492-N23		6676503	
	4	MOUNTING RAIL - ALLEN BRADLEY	AB		1492-N22		6676502	
	2	ALUMINUM MOUNTING CHANNEL	POWER STRUT		PS700J-10-AL			
LGND, RGND	2	1" X 1/4" X 76" COPPER GROUNDING RAIL					4596000	PER DETAIL 7
	2	GROUND LUG	BURNDY		KA28			
WIREWAY	4	3" X 3" WIREWAY	PANDUIT		F3X3LG6		6630803	
	4	3" WIREWAY COVER	PANDUIT		C3LG6			
	1	21" 3/4"x19" CONTROL SWITCH PLATE						
BLANK	1	3 1/2"x19" BLANK PANEL						
BLANK	1	5 1/4"x19" BLANK PANEL						
2" GROMMET	1	SNAP BUSHING FITS 2" HOLE	HEYCO		2400			
AC RECEPT	1	120VAC 20A DUPLEX RECEPTACLE	HUBBELL		HBL5362			
	1	HANDY BOX	APPLETON		180-1/2			
	1	RECEPTACLE COVER	APPLETON		180W			
LCOM 840	3 OR 4, 5	COAXIAL ADAPTERS, BNC (M-F-F)	LCOM		BA840		9401741	
LCOM BC55	1	BNC FEMALE TO 2-WIRE BREAKOUT	LCOM		BC55			
GS	1	GROUND SWITCH	STATES	SJK	20K01-B		6943300	
85 OR 85/TT, TT	1 OR 2	ON/OFF CARRIER/FREQUENCY SHIFT KEY CARRIER	PULSAR	UPLC II	US1NEM7NFSX	125V DC	6659052	
	1	1RU CHASSIS FLUSH MOUNTING	PULSAR	1088-780			6650699	
SKEWED HYBRID	1	SKEWED HYBRID	PULSAR		CH20-SKWMN-001		6650705	
BALANCED HYBRID	1	RESISTIVE HYBRID	PULSAR		CH20-BALMN-001		6650700	
94/TTR	1	LATCHING RELAY	ABB	RXMVB4	RK251402-AP			
	1	RELAY CASE (MOUNTING KIT ASSEMBLY TO INCLUDE CONTACT SOCKETS, 10A, P/N:IMRK002136-A)	ABB	RHGX4	AI56190001-A		6676402	
TERM RESISTOR	1	BNC TERMINAL, 50-OHM TO RG-58 COAXIAL	AMPHENOL		RF 00-46650-51RFX			

KEYED DESIGN NOTES

1. VERIFY RELAY CONFIGURATION AND PART NUMBERS PRIOR TO ISSUING PRINT. STANDARD ASSUMES SEL-411L IS AN 87LP DEVICE, BUT CAN ALSO BE UTILIZED AS A 21P DEVICE. VERIFY WITH MP COMMUNICATIONS & RELAYING ENGINEERING. 311C TO BE 3RU DITHERED OPTION FOR RING APPLICATIONS.
2. MODIFY TEST SWITCH TYPES & NAME TO SUIT CONTROL REQUIREMENTS.
3. INSTALL 1-SA BLOCK PER I/O CARD INSTALLED.
4. FIBER TRANSCIEVER CHOSEN BY DISTANCE. VERIFY WITH MP RELAYING & COMMUNICATIONS ENGINEERING.
5. VERIFY COMMUNICATION REQUIREMENTS WITH ENGINEERING. DELETE UNNECESSARY EQUIPMENT.
6. FILL IN BLANKS WITH INFORMATION FROM ENGINEERING M&R. REMOVE MOD CONTROL SWITCH & FUSES IF NOT REQUIRED.
7. LEAVE AT LEAST 1RU BLANK BETWEEN I/O AND OTHER RACK EQUIPMENT FOR PANEL SIS WIRING.
8. SET UP FOR RADIAL BUS. IF RING-BUS CONNECTED, CHANGE FUSES FROM "BPP" AND "BPS" TO "LPP" AND "LSS".
9. OMIT IF PARALLEL POTENTIAL NOT PRESENT ON BUS(ES) LINE IS CONNECTED TO. 2P22BA FOR WHEN BUS 2 IS NORMAL. 2P22ZA FOR WHEN BUS 1 IS NORMAL.
10. FOR END OF IRIG CHAIN; OMIT IF IRIG CHAIN DOES NOT END AT THIS PANEL.
11. ADJUST END CLAMPS BASED ON PANEL'S DINRAIL-MOUNTED DEVICE CONFIGURATIONS. INCLUDE ONE CLAMP ABOVE AND BELOW EACH FUSE HOLDER.
12. UPDATE 43/TTT AND 43/TTR SWITCHES TO 6 DECKS IF RING CONFIGURED.
13. USE 3RU SIZE FOR RING POSITION SEL-311C; USE 2RU SIZE FOR RADIAL POSITION.

REMOVE ALL KEYED DESIGN NOTES. CHANGE ALL ITEMS SHOWN IN GREY TO CORRECT LAYER IF USED IN THE DESIGN. DELETE THE "Z-DESIGN (DELETE)" LAYER.

NOTES:

1. VENDOR SHALL MOUNT TERMINAL BLOCKS AT 45° ANGLE FROM WING PER DETAIL 2
2. GROUND ALL CT'S AND CABLE SHIELDS ON GROUND RAIL.

NO.	DATE	REVISION DESCRIPTION	BY	APPROVED	NO.	DATE	REVISION DESCRIPTION	BY	APPROVED
A	08-25-22	MP STANDARDS - FINAL ISSUE	PJK/BV	GTJ/BV	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.

DRAWN BY .
APPROVED
DATE .
SCALE 1 1/2" = 1'-0"

minnesota power
AN ALLETE COMPANY

115kV STANDARD
LINE PANEL (411L/311C)
ELEVATION & BILL OF MATERIALS

SHEET 1 REV. A

ME-35702-09

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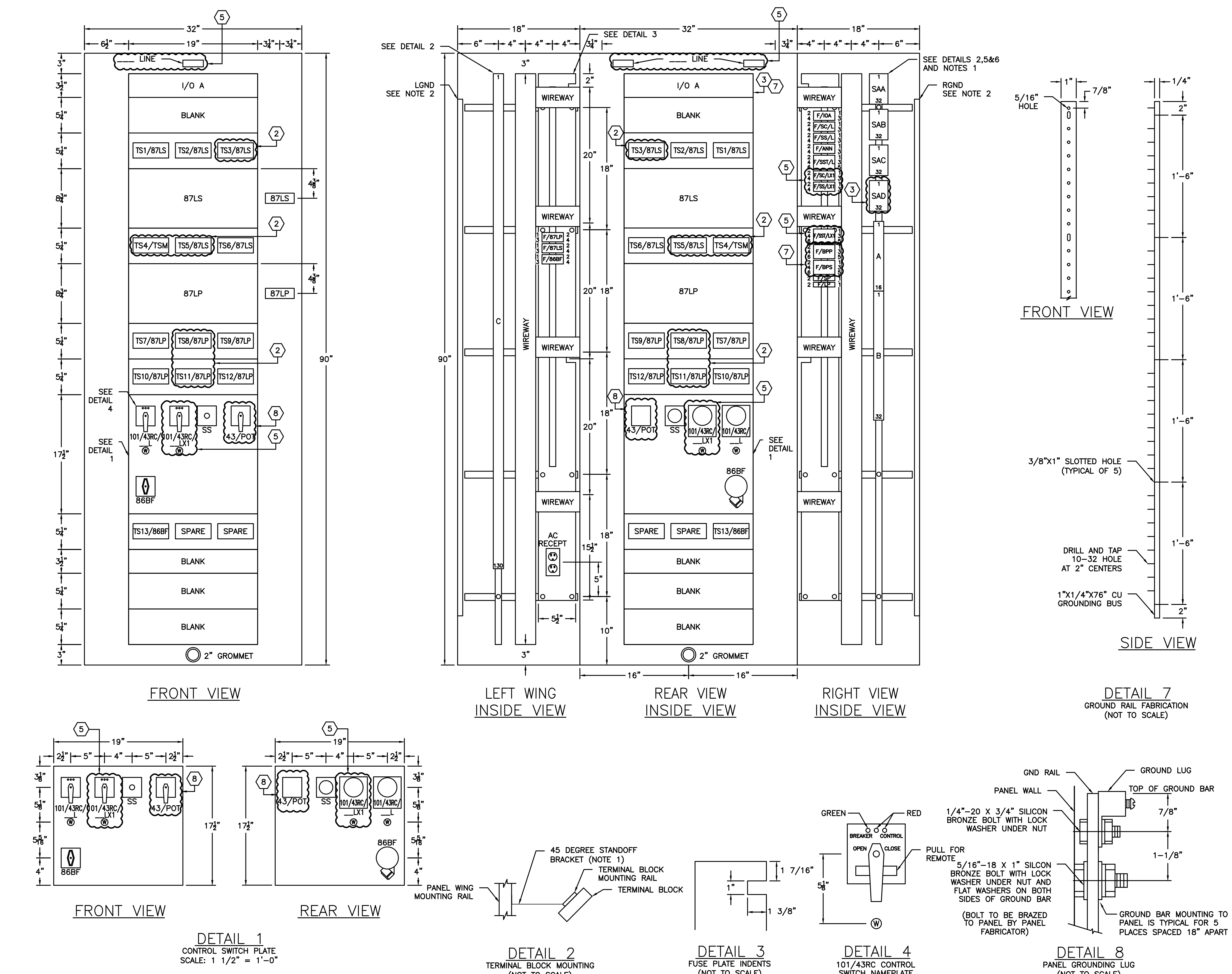
CODE . 3200 3508

ImageSite: .



FRONT VIEW

LEFT WING INSIDE VIEW

REAR VIEW INSIDE VIEW

RIGHT VIEW INSIDE VIEW

DETAIL 7
GROUND RAIL FABRICATION
(NOT TO SCALE)

FRONT VIEW REAR VIEW

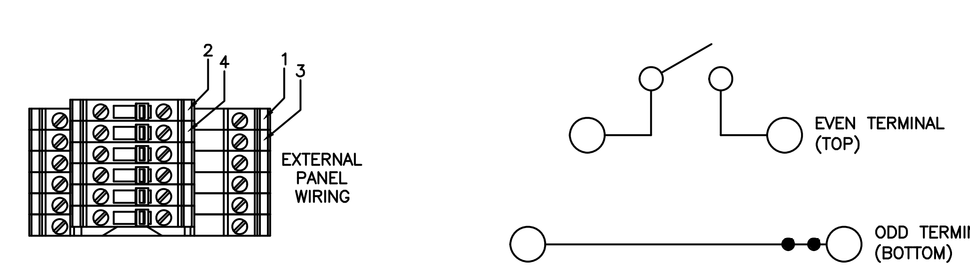
DETAIL 1
CONTROL SWITCH PLATE
SCALE: 1 1/2" = 1'-0"

DETAIL 2
TERMINAL BLOCK MOUNTING
(NOT TO SCALE)

DETAIL 3
FUSE PLATE INDENTS
(NOT TO SCALE)

DETAIL 4
101/43RC CONTROL SWITCH NAMEPLATE
(NOT TO SCALE)

DETAIL 8
PANEL GROUNDING LUG
(NOT TO SCALE)



DETAIL 5
KNIFE DISCONNECT INSTALLATION DETAIL
(NOT TO SCALE)

DETAIL 6
KNIFE DISCONNECT CIRCUIT DIAGRAM
(NOT TO SCALE)

MARK	QTY	DEVICE	MFGR.	TYPE	CATALOG NO.	RANGE	STORES	REMARKS
87LP	1	MICRO PROCESSOR DISTANCE RELAY	SEL	411L	0411L1X6X5B8D0XH52424XX OR 0411L1X6X5B8H0XH2424XX (11)			
87LS	1	MICRO PROCESSOR DISTANCE RELAY	SEL	411L	0411L1X6X5B8D0XH52424XX OR 0411L1X6X5B8H0XH2424XX (11)			
I/O A	1	ORION I/O	NOVATECH		I/O-SX-EP-411X-AD-WR 42-44-98			
	5	TEST SWITCH RACK ASSEMBLY	ABB	FT-19	FR3G000000000		6602412	
TS4/TSM, TS5/87LS, TS6/87LS, TS8/87LP, TS9/87LP	3 OR 5	TEST SWITCH – 6C – 4P RACK MOUNTED	ABB	FT-19	R129A514G01		6602403	
TS1/87LS, TS2/87LS, TS3/87LS, TS7/87LP, TS10/87LP, TS11/87LP, TS12/87LP, TS13/86BF	6 OR 8	TEST SWITCH – 10P RACK MOUNTED	ABB	FT-19	R129A501G01		6602404	
W	1 OR 2	WHITE ILLUMINATING LIGHT	GE	ET-16 LED	116B6708G43W73W5		6646003	
SS	1	SYNCH SWITCH ENGRAVING CODE: 11D-2S17	ELECTRO	SERIES 24	2424E		6650755	
	1	SYNCH SWITCH OVAL REMOVABLE HANDLE	ELECTRO	002013-3				
101/43RC/__L 101/43RC/__LX1	1 OR 2	BREAKER CONTROL SWITCH ENGRAVING CODE: 123B-2B36A	ELECTRO	SERIES 24	88PDGRRX203FCLA		6650777	
86BF	1	BKR FAIL LOR ENGRAVING CODE: 17C-2L22	ELECTRO	SERIES 24	7806D		6658201	
	1	BLUE HANDLE	ELECTRO	02000-11A-7				FOR 86BF
43/POT	1	POTENTIAL TRANSFER SWITCH ENGRAVING CODE: 010D-2P22BA OR 010D-2P22AZ	ELECTRO	SERIES 24	24203B			
F/LP, F/SP	2	1-POLE FUSE HOLDER	MERSEN	ULTRASAFE	USCC1		3084985	
F/87LP, F/87LS, F/SC/L, F/SS/L, F/86BF, F/IO, F/ANN, F/SC/LX1, F/SS/LX1	7 OR 9	2-POLE FUSE HOLDER	MERSEN	ULTRASAFE	USCC2		3084990	
F/BPP, F/BPS F/SST/L, F/SST/LX1	3 OR 4	3-POLE FUSE HOLDER	MERSEN	ULTRASAFE	USCC3		3084995	
	15 OR 18	FUSE ANCHORS	PHOENIX	E/NS 35N	800886		6676506	FOR DIN-MOUNTED DEVICES
	14	10A FUSES	MERSEN	10A	ATMR10		3000110	
	2 OR 4	6A FUSES	MERSEN	6A	ATMR6		3000106	
	7 OR 12	3A FUSES	MERSEN	3A	ATMR3		3000103	
	2	1A FUSE	MERSEN	1A	ATMR1		3000101	
SAA, SAB, SAC, SAD	48 OR 64	KNIFE DISCONNECT S-TERMINAL BLOCKS	PHOENIX	UTTB-4-MT	3044775		6676505	
	3 OR 4	S-BLOCK END COVER	PHOENIX	D-UTTB 2.5/4	3047293			
	4 OR 5	S-BLOCK END CLAMP	PHOENIX	CLIPFIX 35-5	3022276			
	3 OR 4	TERMINAL STRIP MARKER CARRIER	PHOENIX	KLM 3	811969			
	1	MOUNTING RAIL – PHOENIX	PHOENIX	NS35/7.5	0801733		6676507	
	3 OR 4	TERMINAL BLOCK MARKER	PHOENIX	ZB 6, QR	1051029:0001			LABELED 1-10
	3 OR 4	TERMINAL BLOCK MARKER	PHOENIX	ZB 6, QR	1051029:0011			LABELED 11-20
	3 OR 4	TERMINAL BLOCK MARKER	PHOENIX	ZB 6, QR	1051029:0021			LABELED 21-30
	3 OR 4	TERMINAL BLOCK MARKER	PHOENIX	ZB 6, QR	1051029:0031			LABELED 31-40
A, B, C	178	A-B-C TERMINAL BLOCKS	AB		1492-CD3		6676500	
	3	A-B-C BLOCK END BARRIER	AB		1492-N16		6676501	
	6	A-B-C BLOCK END ANCHOR	AB		1492-N23		6676503	
	4	MOUNTING RAIL – ALLEN BRADLEY	AB		1492-N22		6676502	
	2	ALUMINUM MOUNTING CHANNEL	POWER STRUT		PS700J-10-AL			
LGND, RGND	2	1" X 1/4" X 76" COPPER GROUNDING RAIL					4596000	PER DETAIL 7
	2	GROUND LUG	BURNDY		KA28			
WIREWAY	4	3" X 3" WIREWAY	PANDUIT		F3X3LG6		6630803	
	4	3" WIREWAY COVER	PANDUIT		C3LG6			
	1	17 1/2" 3/4"x19" CONTROL SWITCH PLATE						
BLANK	3	5 1/4"x19" BLANK PANEL						
BLANK	1	3 1/2"x19" BLANK PANEL						
2" GROMMET	1	SNAP BUSHING FITS 2" HOLE	HEYCO		2400			
AC RECEPT	1	120VAC 20A DUPLEX RECEPTACLE	HUBBELL		HBL5362			
	1	HANDY BOX	APPLETON		180-1/2			
	1	RECEPTACLE COVER	APPLETON		180W			
	3	COAXIAL ADAPTERS, BNC (M-F-F)	LCOM		BA840		9401741	
	1	BNC FEMALE TO 2-WIRE BREAKOUT	LCOM		BC55			
TERM RESISTOR	1	BNC TERMINAL, 50-OHM TO RG-58 COAXIAL	AMPHENOL		RF 00-46650-51RFX			

KEYED DESIGN NOTES

1. VERIFY RELAY CONFIGURATION AND PART NUMBERS PRIOR TO ISSUING PRINT.
2. MODIFY TEST SWITCH TYPES TO SUIT CONTROL REQUIREMENTS.
3. INSTALL 1-SA BLOCK PER I/O CARD INSTALLED.
4. VERIFY COMMUNICATION REQUIREMENTS WITH ENGINEERING. DELETE UNNECESSARY EQUIPMENT.
5. FILL IN BLANKS WITH INFORMATION FROM ENGINEERING M&R. REMOVE MOD CONTROL SWITCH & FUSES IF NOT REQUIRED.
6. LEAVE AT LEAST 1RU BLANK BETWEEN I/O AND OTHER RACK EQUIPMENT FOR PANEL SIS WIRING.
7. SET UP FOR RADIAL BUS. IF RING-BUS CONNECTED, CHANGE FUSES FROM "BPP" AND "BPS" TO "LPP" AND "LSS".
8. VERIFY IF NEEDED FOR SPECIFIC DESIGN. 2P22BA FOR WHEN BUS 2 IS NORMAL 2P22ZA FOR WHEN BUS 1 IS NORMAL.
9. FOR END OF IRIG CHAIN; OMIT IF IRIG CHAIN DOES NOT END AT THIS PANEL.
10. ADJUST END CLAMPS BASED ON PANEL'S DINRAIL-MOUNTED DEVICE CONFIGURATIONS. INCLUDE ONE CLAMP ABOVE AND BELOW EACH FUSE HOLDER.
11. USE THIS PART NUMBER FOR C37.94 FIBER DIFFERENTIAL CHANNEL CARD IF REQUIRED.

REMOVE ALL KEYED DESIGN NOTES. CHANGE ALL ITEMS SHOWN IN GREY TO CORRECT LAYER IF USED IN THE DESIGN. DELETE THE "Z-DESIGN (DELETE)" LAYER.

NOTES:

1. VENDOR SHALL MOUNT TERMINAL BLOCKS AT 45° ANGLE FROM WING PER DETAIL 2
2. GROUND ALL CT'S AND CABLE SHIELDS ON GROUND RAIL.

NO.	DATE	REVISION DESCRIPTION	BY	APPROVED	NO.	DATE	REVISION DESCRIPTION	BY	APPROVED
A	09-07-22	MP STANDARDS – FINAL ISSUE	PJK/BV	GTJ/BV	.	.	.	.	.
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DRAWN BY .
APPROVED .
DATE .
SCALE 1 1/2" = 1'-0"

minnesota power
AN ALLETE COMPANY

115kV STANDARD
LINE PANEL (411L/411L)
ELEVATION & BILL OF MATERIALS

SHEET 1 REV. A

ME-35702-10

CADD DRAWING – FOR REPRODUCTION ONLY

MICROFILMED / /

CODE . 3200 3508

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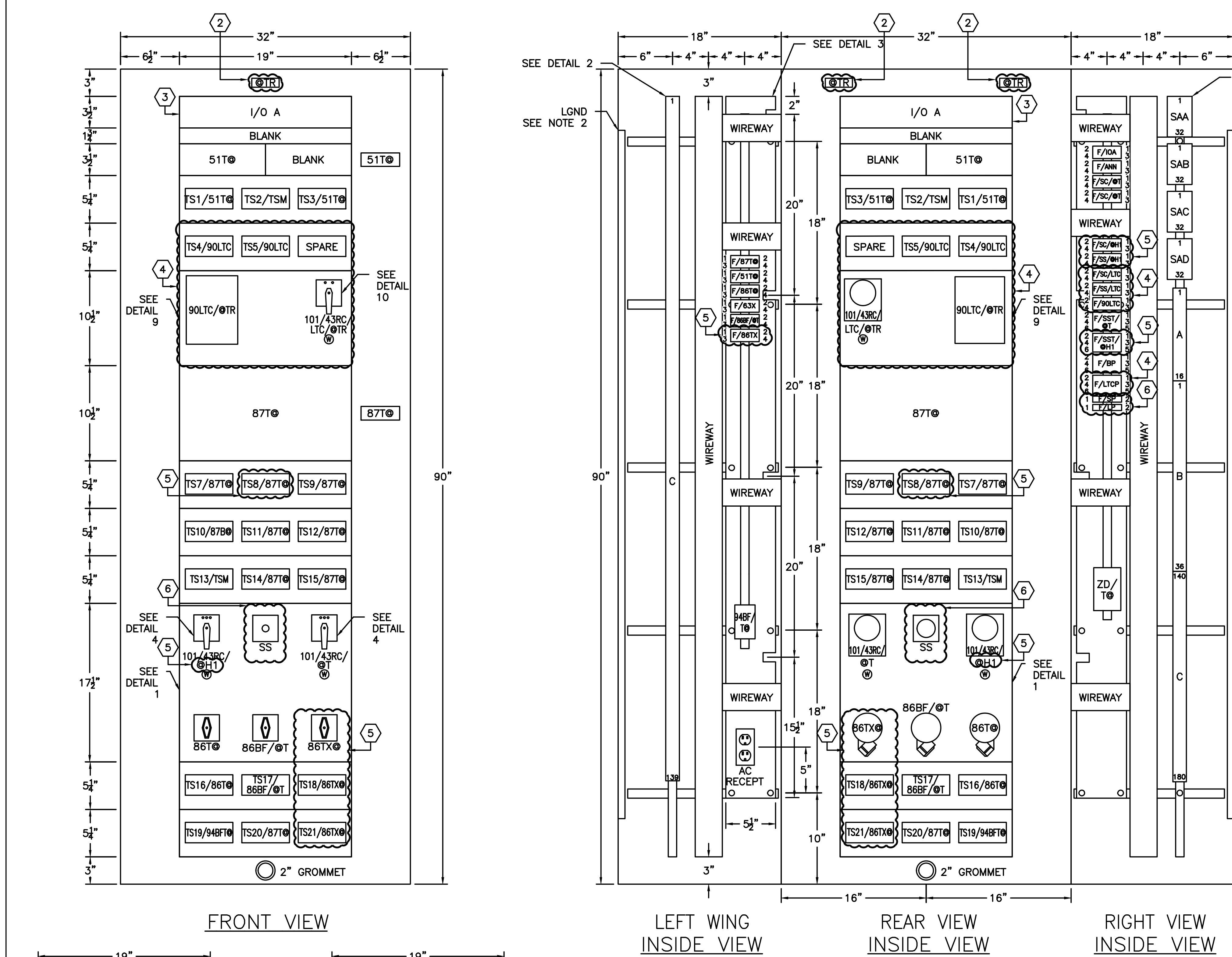
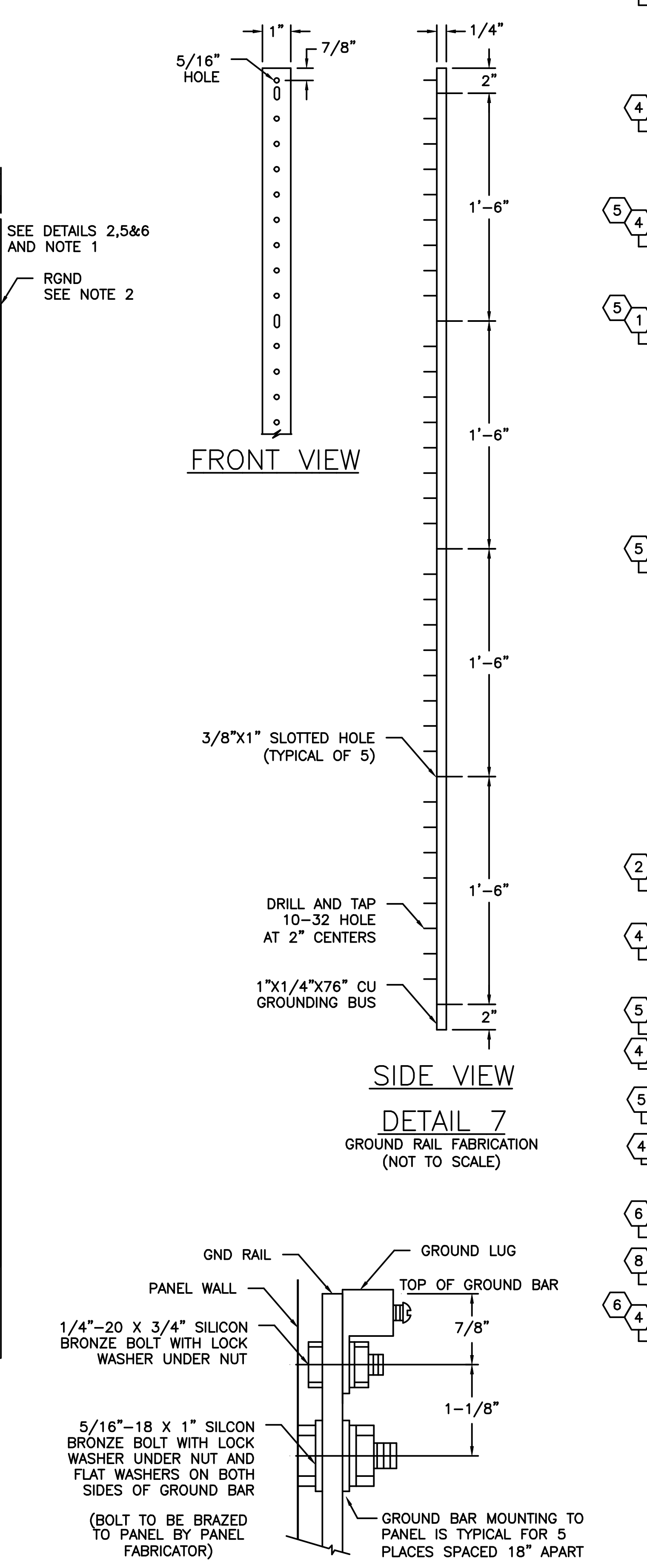
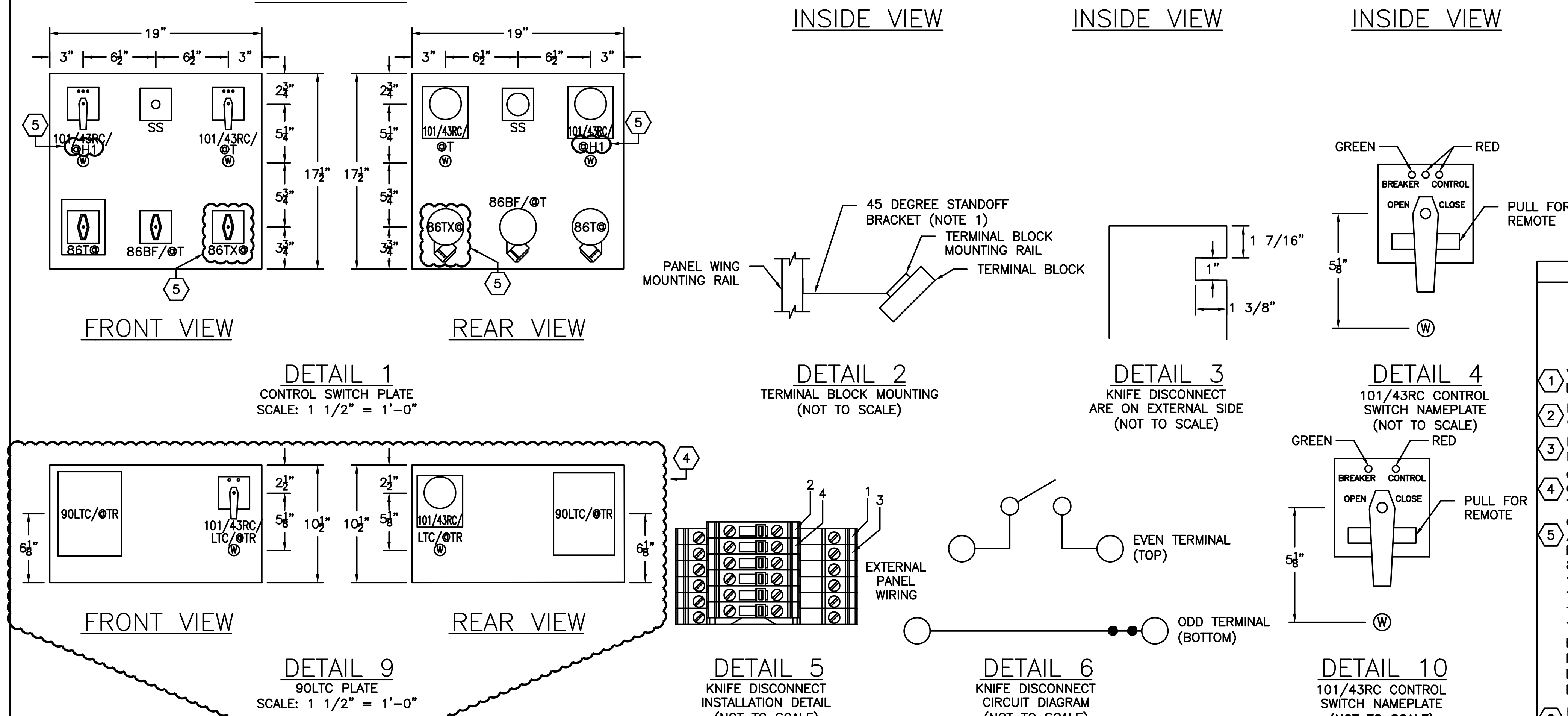




DETAIL 7
GROUND RAIL FABRICATION
(NOT TO SCALE)

DETAIL 8
PANEL GROUNDING LUG
(NOT TO SCALE)



DETAIL 1
CONTROL SWITCH PLATE
SCALE: 1 1/2" = 1'-0"

DETAIL 2
TERMINAL BLOCK MOUNTING
(NOT TO SCALE)

DETAIL 3
KNIFE DISCONNECT ARE ON EXTERNAL SIDE
(NOT TO SCALE)

DETAIL 4
101/43RC CONTROL SWITCH NAMEPLATE
(NOT TO SCALE)

DETAIL 9
90LTC PLATE
SCALE: 1 1/2" = 1'-0"

DETAIL 5
KNIFE DISCONNECT INSTALLATION DETAIL
(NOT TO SCALE)

DETAIL 6
KNIFE DISCONNECT CIRCUIT DIAGRAM
(NOT TO SCALE)

DETAIL 10
101/43RC CONTROL SWITCH NAMEPLATE
(NOT TO SCALE)

NOTES:

1. VENDOR SHALL MOUNT TERMINAL BLOCKS AT 45° ANGLE FROM WING PER DETAIL 2
2. GROUND ALL CT'S AND CABLE SHIELDS ON GROUND RAIL.

MARK	QTY	DEVICE	MFGR.	TYPE	CATALOG NO.	RANGE	STORES	REMARKS
87T@	1	TRANSFORMER PROTECTION RELAY	SEL	487E	0487E3X611XXB0X4H624XXX			
51T@	1	TRANSFORMER PROTECTION RELAY	SEL	551C	0551C0BX5B3X		6659019	W/ RACK MOUNT BRACKET 9100
I/O A	1	ORION I/O	NOVATECH		I/O-SX-EP-4111-AD-WR 42-44-98			
90LTC/@TR	1	PROGRAMMABLE AUTOMATION CONTROLLER TRANSFORMER LTC CONTROL MODULE	SEL	2411	2411A1A5X3A71850140			
	6 OR 7	TEST SWITCH RACK ASSEMBLY	ABB	FT-19	FR3G000000000		6602412	
TS1/51T@, TS2/TSM, TS3/51T@, TS7/87T@, TS4/90LTC, TS8/87T@, TS9/87T@, TS10/87T@, TS11/87T@, TS12/87T@, TS13/TSM	9 OR 11	TEST SWITCH - 6C - 4P RACK MOUNTED	ABB	FT-19R	R129A514G01		6602403	
TS5/90LTC, TS14/87T@, TS15/87T@, TS16/86T@, TS17/86BF/@T, TS18/86TX@, TS19/94BFT@, TS20/87T@, TS21/86TX@	8 OR 9	TEST SWITCH - 10P RACK MOUNTED	ABB	FT-19R	R129A501G01		6602404	
SS	1	SYNCH SWITCH W/ENGRAVING CODE 11D-2S17	ELECTRO	SERIES 24	2424E		6650755	
	1	SYNCH SWITCH OVAL REMOVABLE HANDLE	ELECTRO	002013-3				
86TX@	1	ELECTRONICALLY RESETABLE LOR W/NAMEPLATE ENGRAVING 17C-2L22	ELECTRO	SERIES 24	7828DD		6658202	
	1	ORANGE HANDLE	ELECTRO	02000-11A-7			6658751	FOR 86TX@
86T@	1	TRANSFORMER DIFF LOR W/NAMEPLATE ENGRAVING 17C-2L22	ELECTRO	SERIES 24	7806D		6658201	
	1	ORANGE HANDLE	ELECTRO	02000-11A-7			6658751	FOR 86T@
86BF/@T	1	TRANSFORMER DIFF LOR W/NAMEPLATE ENGRAVING 17C-2L22	ELECTRO	SERIES 24	7806D		6658201	
86BF/@H	1	TRANSFORMER DIFF LOR W/NAMEPLATE ENGRAVING 17C-2L22	ELECTRO	SERIES 24	7808D		6658202	
	1 OR 2	BLUE HANDLE	ELECTRO	02000-11A-2				FOR 86BF/@H, 86BF/@T
94BFT@	1	CONTROL RELAY	SQD	XUD0	8501XUD080V63		6650600	
101/43RC/@H1 101/43RC/@T	2	BREAKER CONTROL SWITCH W/ ENGRAVING CODE: 123B-2B36A	ELECTRO	SERIES 24	88PDGRRX203FCLA		6650777	
101/43RC/LTC/@TR	1	LTC CONTROL SWITCH	ELECTRO	SERIES 24	88PBGXRX203FCLA			
W	2 OR 3	WHITE ILLUMINATING LIGHT	GE	ET-16 LED	116B6708G43W73W5		6646003	
F/BP, F/SST/@H1 F/SST/@T, F/LTCP	3 OR 4	3-POLE FUSE HOLDER	MERSEN	ULTRASAFE	USCC3		3084995	
F/51T@, F/86T@, F/87T@, F/86BF/@T, F/63X, F/86TX, F/90LTC, F/SC/@H1, F/SC/@T, F/SC/LTC, F/SS/@H1, F/SS/@T, F/SS/LTC, F/IOA, F/ANN	12 OR 15	2-POLE FUSE HOLDER	MERSEN	ULTRASAFE	USCC2		3084990	
F/LP, F/SP	2	1-POLE FUSE HOLDER	MERSEN	ULTRASAFE	USCC1		3084985	
	22 OR 24	FUSE ANCHORS	PHOENIX	E/NS 35N	800886		6676506	
	17 OR 22	10A FUSES	MERSEN	10A	ATMR10		3000110	
	4 OR 6	6A FUSES	MERSEN	6A	ATMR6		3000106	
	12 OR 14	3A FUSES	MERSEN	3A	ATMR3		3000103	
	2	1A FUSE	MERSEN	1A	ATMR1		3000101	
SAA, SAB, SAC, SAD	64	KNIFE DISCONNECT S-TERMINAL BLOCKS	PHOENIX	UTTB-4-MT	3044775		6676505	
	4	S-BLOCK END COVER	PHOENIX	D-UTTB 2,5/4	3047293			
	5	S-BLOCK END CLAMP	PHOENIX	CLIPFIX 35-5	3022276			
	4	TERMINAL STRIP MARKER CARRIER	PHOENIX	KLM 3	811969			
	1	MOUNTING RAIL - PHOENIX	PHOENIX	NS35/7,5	0801733		6676507	
	4	TERMINAL BLOCK MARKER	PHOENIX	ZB 6, QR	1051029:0001			LABELED 1-10
	4	TERMINAL BLOCK MARKER	PHOENIX	ZB 6, QR	1051029:0011			LABELED 11-20
	4	TERMINAL BLOCK MARKER	PHOENIX	ZB 6, QR	1051029:0021			LABELED 21-30
	4	TERMINAL BLOCK MARKER	PHOENIX	ZB 6, QR	1051029:0031			LABELED 31-40
A, B, C	232	A-B-C TERMINAL BLOCKS	AB		1492-CD3		6676500	
	4	A-B-C BLOCK END BARRIER	AB		1492-N16		6676501	
	8	A-B-C BLOCK END ANCHOR	AB		1492-N23		6676503	
	4	MOUNTING RAIL - ALLEN BRADLEY	AB		1492-N22		6676502	
	2	ALUMINUM MOUNTING CHANNEL	POWER STRUT		PS700J-10-AL			
LGND, RGND	2	1" X 1/4" X 76" COPPER GROUNDING RAIL					4596000	PER DETAIL 8
	2	GROUND LUG	BURNDY		KA28			
WIREWAY	4	3" X 3" WIREWAY	PANDUIT		F3X3LG6		6630803	
	4	3" WIREWAY COVER	PANDUIT		C3LG6			
	1	METAL OXIDE VARISTOR	LITTELFUSE		V20E150P			
	1	17 1/2"X19" CONTROL SWITCH PLATE						
BLANK	1	1 3/4" X 19" BLANK PLATE						
	1	10 1/2"X19" BLANK PLATE OR 10 1/2"X19" 90LTC MOUNTING PLATE						
AC RECEPT	1	120 VAC, 20A, DUPLEX RECEPTACLE	HUBBELL		HBL5362			
	1	HANDY BOX	APPLETON		180-1/2			
	1	RECEPTACLE COVER	APPLETON		180W			
2" GROMMET	1	SNAP BUSHING FITS 2" HOLE	HEYCO		2400			
	2 OR 3	COAXIAL ADAPTERS BNC (M-F-F)	LCOM		BA840		9401741	
	1 OR 2	BNC FEMALE TO LEADS	LCOM		BC55			
TERM RESISTOR	1	BNC TERMINAL, 50-OHM TO RG-58 COAXIAL	AMPHENOL		RF 00-46650-51RFX			
ZD/T@	1	ZENER DIODE	ABB	TRB-2	408C003G01		6650402	

KEYED DESIGN NOTES

THIS DESIGN UTILIZES A TERMINATION CABINET. IF NONE EXISTS, UPDATE REFERENCES & CIRCUITS TO ADJACENT PANELS AND EQUIPMENT.

MODIFY TEST SWITCHES TO SUIT CONTROL REQUIREMENTS PER STATION CONFIGURATION AND NOTES ON SH.2.

1. VERIFY RELAY CONFIGURATION AND PART NUMBERS WITH MP RELAY ENGINEERING PRIOR TO ISSUING PRINT.
2. FILL IN BLANKS WITH INFORMATION FROM ENGINEERING M&R. REMOVE MOD CONTROL SWITCH IF NOT REQUIRED.
3. LEAVE AT LEAST 1RU BLANK BETWEEN I/O AND OTHER RACK EQUIPMENT FOR PANEL SIS WIRING.
4. COORDINATE WITH MP RELAY AND CONTROL ENGINEERING TO DETERMINE LTC CONTROL REQUIREMENTS. OMIT LTC-RELATED DEVICES AND INSERT 1-3RU & 1-5RU BLANK PLATE IF NOT REQUIRED.
5. CONFIGURATION SHOWN FOR TRANSFORMER HIGH-SIDE MOD PROTECTION. IF A HIGH-SIDE BREAKER OR CIRCUIT SWITCHER IS USED, REPLACE 86TX ELECTRONICALLY RESETABLE LOR WITH BREAKER CONTROL LOR NAMED 86BF/@H, AND RENAME THE FOLLOWING DEVICES:
   101/43RC/@H1 TO 101/43RC/@H
   TS8/87T@ INCLUDED IN PANEL
   TS18/86TX@ TO TS18/86BF/@H
   TS21/86TX@ REMOVED
   F/86TX@ TO F/86BF/@H
   F/SST/@H1 TO F/SST/@H
   F/SS/@H1 TO F/SS/@H
   F/SC/@H1 TO F/SC/@H
6. FOR LOW-SIDE SYNCH CAPABILITIES. OMIT IF NO LOW-SIDE BREAKER IS PRESENT.
7. FOR END OF IRIG CHAIN; OMIT IF IRIG CHAIN DOES NOT END AT THIS PANEL.
8. ADJUST END CLAMPS BASED ON PANEL'S FUSE CONFIGURATION. INCLUDE ONE FUSE ABOVE AND BELOW EACH FOLDER.

REMOVE ALL KEYED DESIGN NOTES. CHANGE ALL ITEMS SHOWN IN GREY TO CORRECT LAYER IF USED IN THE DESIGN. DELETE THE "Z-DESIGN (DELETE)" LAYER.

UNIQUE CHARACTER IDENTIFIERS
REPLACE @ WITH TRANSFORMER NUMBER:__
REMOVE ALL UNIQUE CHARACTER IDENTIFIERS NOTES.

NO.	DATE	REVISION DESCRIPTION	BY	APPROVED	NO.	DATE	REVISION DESCRIPTION	BY	APPROVED
A	08-25-22	MP STANDARDS - FINAL ISSUE	PJK/BV	GTJ/BV	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.

DRAWN BY	.
APPROVED	.
DATE	.
SCALE	1 1/2" = 1'-0"

minnesota power
AN ALLETE COMPANY

115/___kV STANDARD
@TR PANEL
ELEVATION & BILL OF MATERIALS

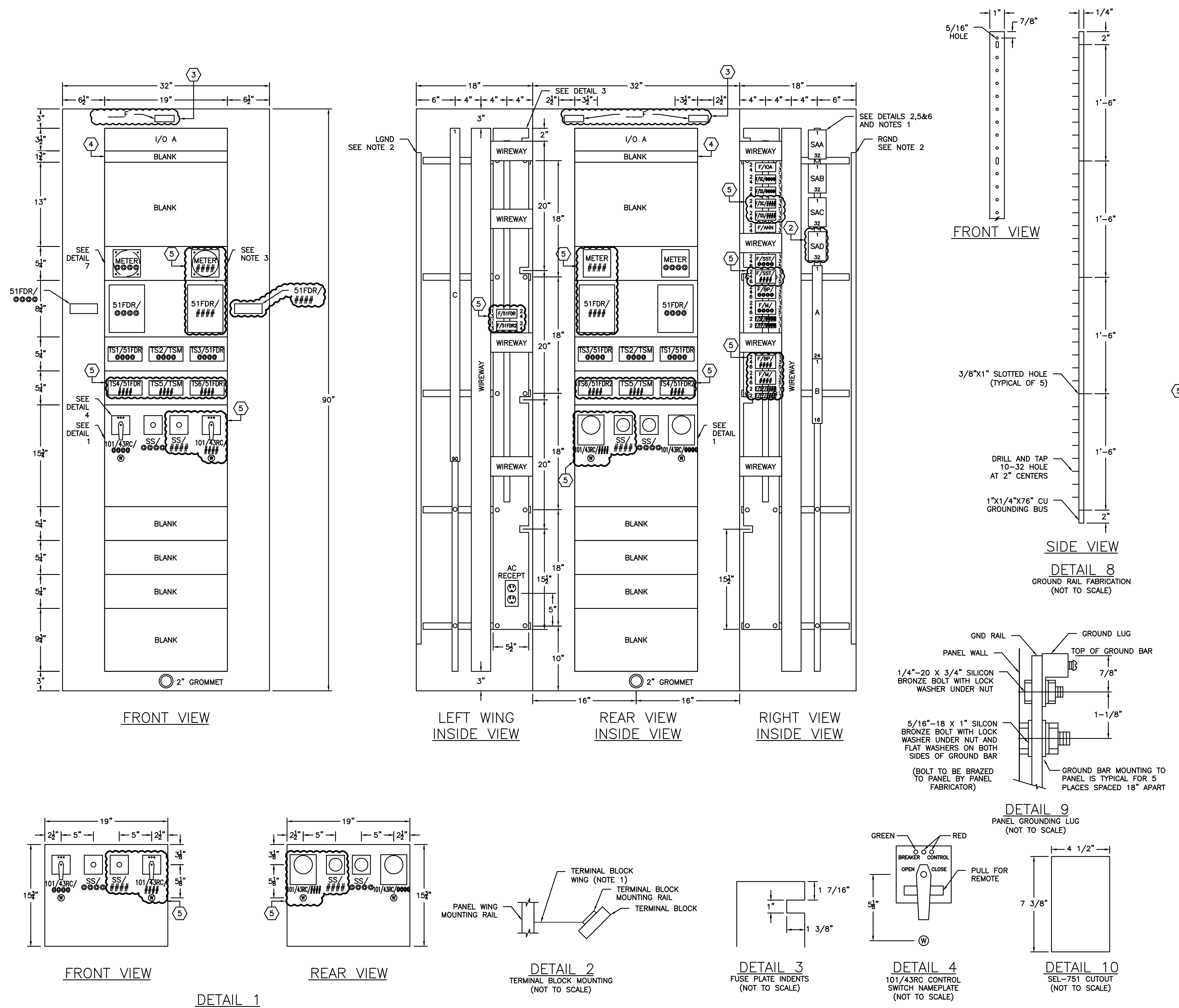
SHEET 1 REV. A

ME-35702-11

CADD DRAWING - FOR REPRODUCTION ONLY

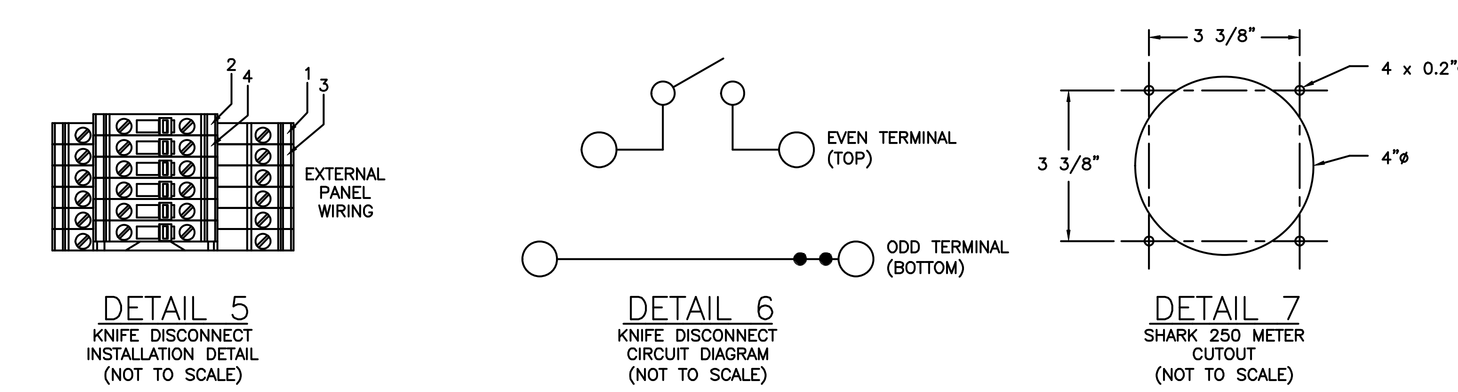
MICROFILMED		CODE	
/ /	.	3200	3508

ImageSite: .



UNIQUE CHARACTER IDENTIFIERS
@@@@: ______ – FEEDER BKR #1
####: ______ – FEEDER BKR #2
REMOVE ALL UNIQUE CHARACTER IDENTIFIERS NOTES.

KEYED DESIGN NOTES
1 VERIFY RELAY CONFIGURATION AND PART NUMBERS WITH MP RELAY ENGINEERING PRIOR TO ISSUING PRINT.
2 INSTALL 1-SA BLOCK PER I/O CARD INSTALLED.
3 FILL IN BLANKS WITH INFORMATION FROM ENGINEERING M&R.
4 LEAVE AT LEAST 1RU BLANK BETWEEN I/O AND OTHER RACK EQUIPMENT FOR PANEL SIS WIRING.
5 ADJUST QUANTITIES AND DELETE NOTE 3 IF PANEL HAS TWO FEEDERS.
6 FOR END OF IRIG CHAIN; OMIT IF IRIG CHAIN DOES NOT END AT THIS PANEL.
7 ADJUST END CLAMPS BASED ON PANEL'S FUSE CONFIGURATION. INCLUDE ONE FUSE ABOVE AND BELOW EACH HOLDER.
REMOVE ALL KEYED DESIGN NOTES. CHANGE ALL ITEMS SHOWN IN GREY TO CORRECT LAYER IF USED IN THE DESIGN. DELETE THE "Z-DESIGN (DELETE)" LAYER.



MARK	QTY	DEVICE	MFGR.	TYPE	CATALOG NO.	RANGE	STORES	REMARKS
51FDR/@@@@ 51FDR/####	1 OR 2	FEEDER PROTECTION RELAY	SEL	751	751401A1A1A70850C20			
	1 OR 2	TEST SWITCH RACK ASSEMBLY	ABB	FT-19	FR3G000000000		6602412	
I/O A	1	ORION I/O	NOVATECH		I/O-SX-EP-411X-AD-WR 42-44-98			
TS1/51FDR@@@@, TS2/TSM/@@@@, TS4/51FDR####, TS5/TSM/####	2 OR 4	TEST SWITCH – 6C – 4P RACK MOUNTED	ABB	FT-19R	R129A514G01		6602403	6C4P
TS3/51FDR@@@@, TS6/51FDR####	1 OR 2	TEST SWITCH – 10P RACK MOUNTED	ABB	FT-19R	R129A501G01		6602404	10P
W	1 OR 2	WHITE ILLUMINATING LIGHT	GE	ET-16 LED	116B6708G43W73W5	125V DC	6646003	
SS/@@@@, SS/####	1 OR 2	SYNCH SWITCH	ELECTRO SWITCH	SERIES 24	2424E		6650755	REMOVABLE HANDLE
		REMOVABLE HANDLE, W/ENGRAVING CODE 11D-2S17						
101/43RC/@@@@ 101/43RC/####	1 OR 2	BREAKER CONTROL SWITCH W/ENGRAVING CODE 123B-2B36A	ELECTRO SWITCH	SERIES 24	88PDGRRX203FCLA		6650777	
F/FP/@@@@, F/FP/#### F/SP/@@@@, F/SP/####	2 OR 4	1-POLE FUSE HOLDER	MERSEN	ULTRASAFE	USCC1		3084985	
F/51FDR, F/51FDR2, F/SC/@@@@, F/SS/@@@@ F/SC/####, F/SS/####, F/ANN, F/IOA	5 OR 8	2-POLE FUSE HOLDER	MERSEN	ULTRASAFE	USCC2		3084990	
F/BP/@@@@, F/SST/@@@@, F/M/@@@@ F/BP/####, F/SST/####, F/M/####	3 OR 6	3-POLE FUSE HOLDER	MERSEN	ULTRASAFE	USCC3		3084995	
	15 OR 22	FUSE ANCHORS	PHOENIX	E/NS 35N	800886		6676506	
	7 OR 14	10A FUSES	MERSEN	10A	ATMR10		3000110	
	2 OR 4	6A FUSES	MERSEN	6A	ATMR6		3000106	
	7 OR 12	3A FUSES	MERSEN	3A	ATMR3		3000103	
	2	1A FUSES	MERSEN	1A	ATMR1		3000101	
	3 OR 6	0.1A FUSES	MERSEN	0.1A	ATMR1/10			
SAA,SAB,SAC	48	KNIFE DISCONNECT TERMINAL BLOCKS	PHOENIX	UTTB 4-MT	3044775		6676505	
	3	END COVER	PHOENIX	D-UTTB 2,5/4	3047293			
	4	END CLAMP	PHOENIX	CLIPFIX 35-5	3022276			
	3 OR 4	TERMINAL BLOCK MARKER	PHOENIX	ZB 6, QR	1051029:0001			LABELED 1-10
	3 OR 4	TERMINAL BLOCK MARKER	PHOENIX	ZB 6, QR	1051029:0011			LABELED 11-20
	3 OR 4	TERMINAL BLOCK MARKER	PHOENIX	ZB 6, QR	1051029:0021			LABELED 21-30
	3 OR 4	TERMINAL BLOCK MARKER	PHOENIX	ZB 6, QR	1051029:0031			LABELED 31-40
	1	MOUNTING RAIL	PHOENIX	NS35/7,5	801733		6676507	
	3 OR 4	"TERMINAL STRIP MARKER CARRIER"	PHOENIX	KLM 3	811969			
A, B, C	130	TERMINAL BLOCKS	AB		1492-CD3	600V, 35A	6676500	
	3	END BARRIER	AB		1492-N16		6676501	
	6	END ANCHOR	AB		1492-N23		6676503	
	4	MOUNTING RAIL	AB		1492-N22		6676502	
	2	ALUMINUM MOUNTING CHANNEL	POWER STRUT		PS700J-10-AL			
LGND, RGND	2	1" X 1/4" X 76" COPPER GROUNDING RAIL					4596000	PER DETAIL 8
	2	GROUND LUG	BURNDY		KA28			
WIREWAY	4	3"X 3" WIREWAY	PANDUIT		F3X3LG6		6630803	GREY
	4	3" WIREWAY COVER	PANDUIT		C3LG6			
BLANK	1	14"x19" BLANK PLATE						
	1	9 3/4"x19" BLANK PLATE						
	1	5 1/4"X19" METER MOUNTING PLATE						
	4	5 1/4"x19" BLANK PLATE						
	1	1 3/4" BLANK PLATE						
	1	8 3/4" RELAY MOUNTING PLATE						
	1	15 3/4"x19" CONTROL SWITCH PLATE						
METER/@@@@ METER/####	1 OR 2	POWER & ENERGY METER	ELECTRO INDUSTRIES	SHARK 250	SHARK250-60-10-V2-D2 -INP100S-X			
AC RECEPT	1	120VAC, 20A DUPLEX RECEPTACLE	HUBBELL		HBL5362			
	1	HANDY BOX	APPLETON		180-1/2			
	1	RECEPTACLE COVER	APPLETON		180W			
2" GROMMET	1	2" SNAP BUSHING	HEYCO		2400			
LCOM BA840	2 OR 3	"COAXIAL ADAPTERS BNC (M-F-F)"	LCOM		BA840		9401741	
LCOM BC55	2 OR 3	BNC FEMALE TO LEADS	LCOM		BC55			
TERM RESISTOR	1	BNC TERMINAL, 50-OHM TO RG-58 COAXIAL	AMPHENOL		RF 00-46650-51RFX			

NOTES:

1. TERMINAL BLOCKS SHALL BE MOUNTED ON WING ATTACHED TO PANEL WING MOUNTING RAIL AT 45° FROM WING. SEE DETAIL 2.
2. GROUND ALL CT CABLES AND CABLE SHIELDS ON GROUND RAILS.
3. FABRICATOR TO CREATE CUTOUT FOR SECOND RELAY AND METER AND COVER FOR FUTURE INSTALLATION.

NO.	DATE	REVISION DESCRIPTION	BY	APPROVED	NO.	DATE	REVISION DESCRIPTION	BY	APPROVED
A	08-25-22	MP STANDARDS – FINAL ISSUE	PJK/BV	GTJ/BV	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.

DRAWN BY .
APPROVED .
DATE .
SCALE 1 1/2" = 1'-0"

minnesota power
AN ALLETE COMPANY

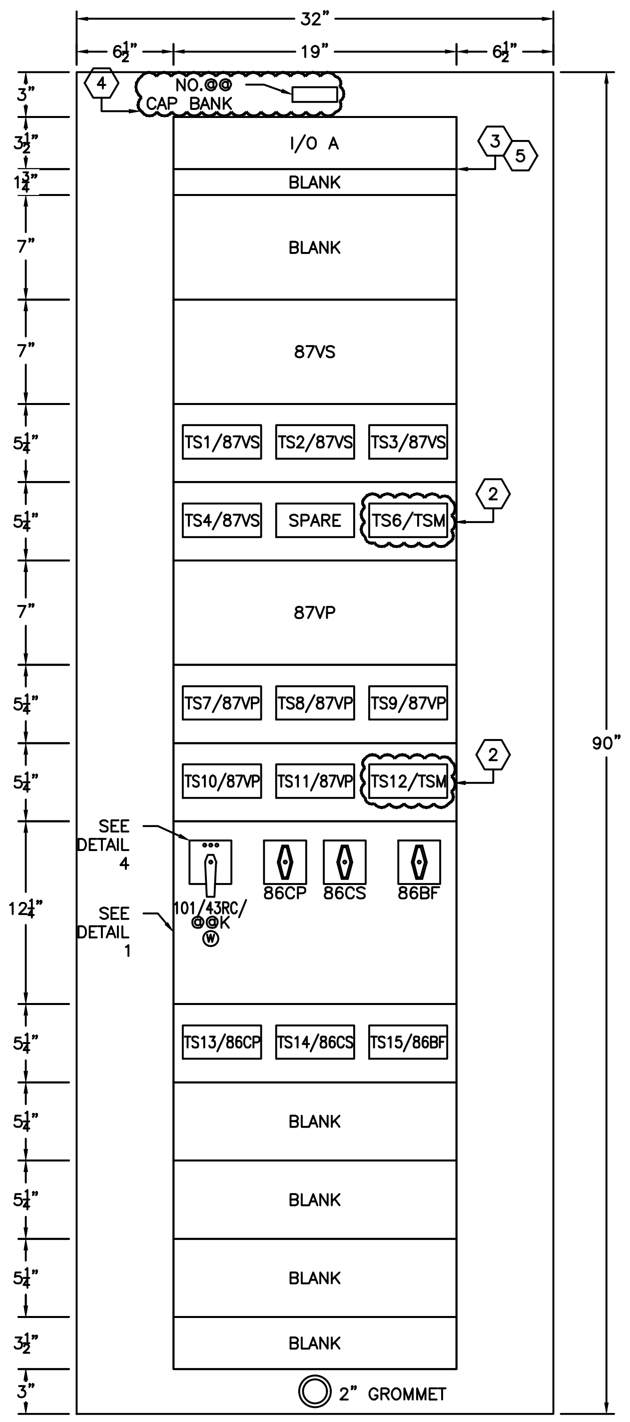
DISTRIBUTION LEVEL kV STANDARD
@@@@ & #### FEEDER PANEL
ELEVATION & BILL OF MATERIALS

SHEET 1 REV. A
ME-35702-12

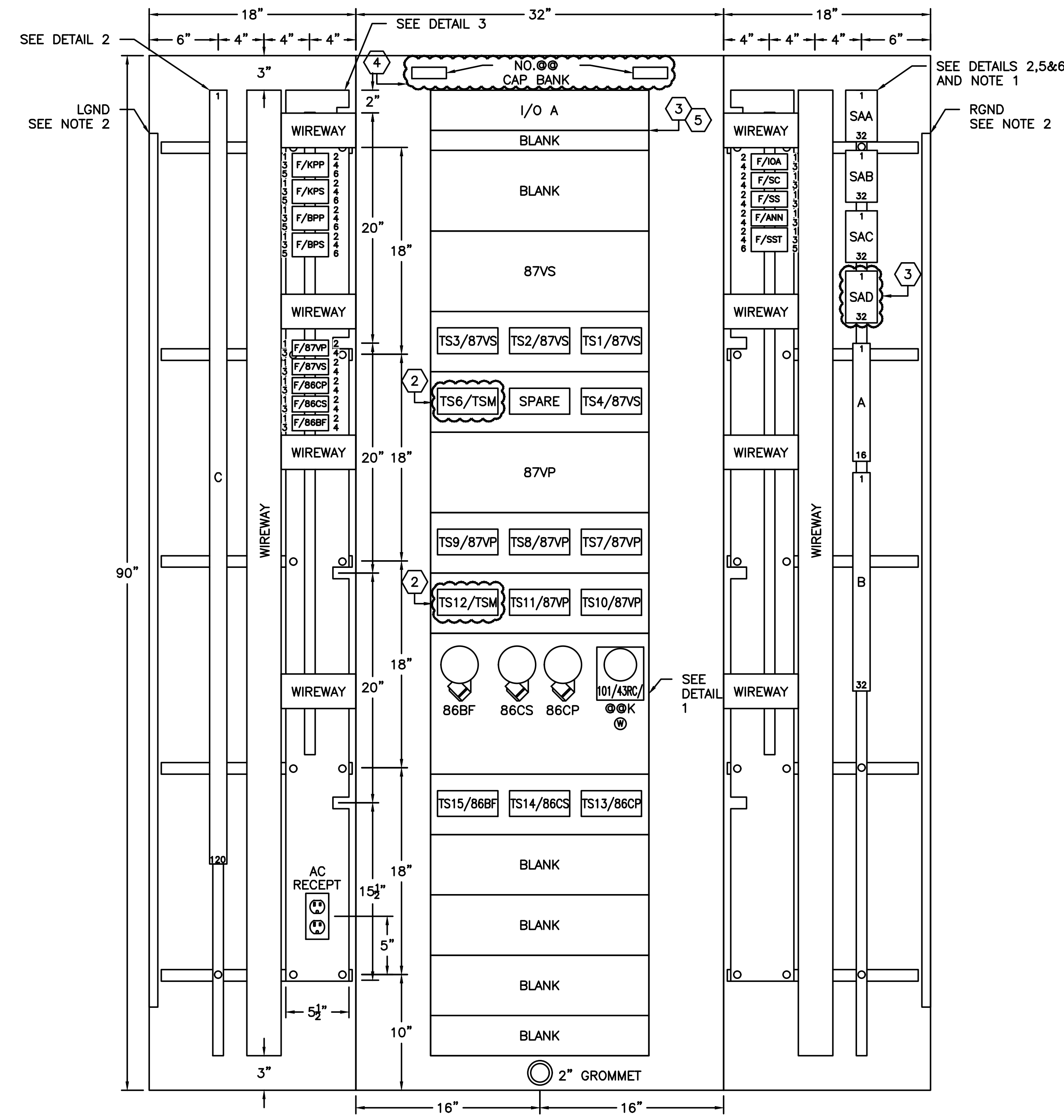
ImageSite: .

CADD DRAWING – FOR REPRODUCTION ONLY

MICROFILMED	CODE		
/ /	.	4400	3508



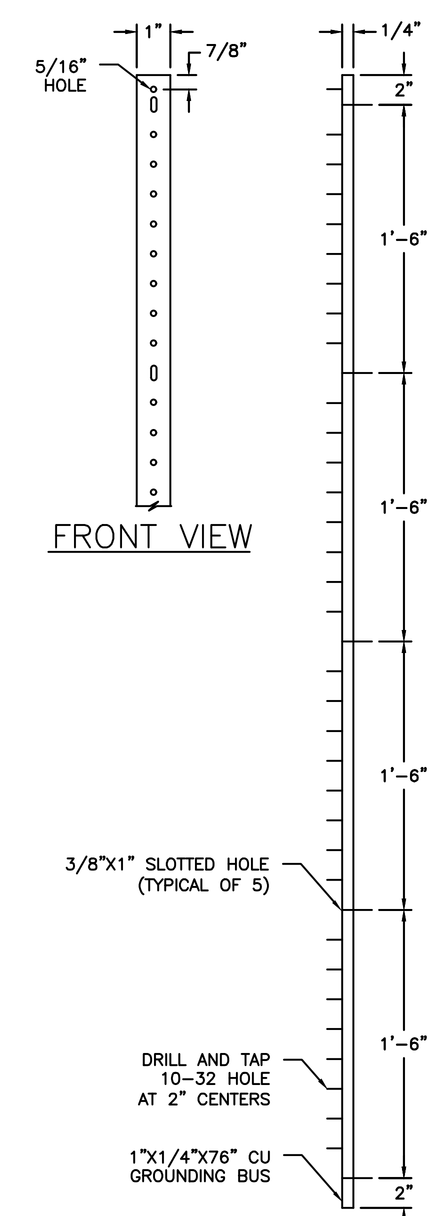
FRONT VIEW



LEFT WING INSIDE VIEW

REAR VIEW INSIDE VIEW

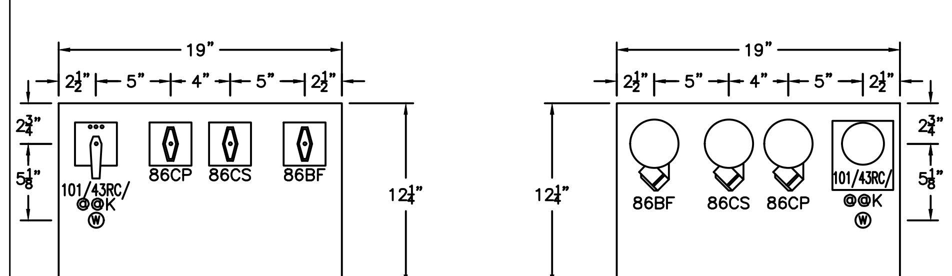
RIGHT VIEW INSIDE VIEW



FRONT VIEW

SIDE VIEW

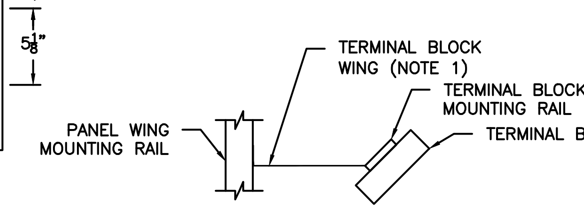
DETAIL 7
GROUND RAIL FABRICATION
(NOT TO SCALE)



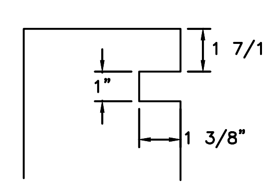
FRONT VIEW

REAR VIEW

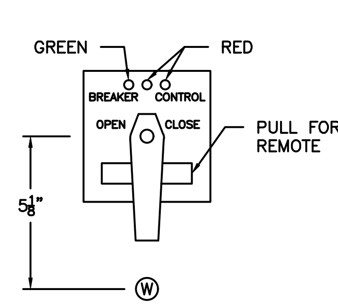
DETAIL 1
CONTROL SWITCH PLATE
SCALE: 1 1/2" = 1'-0"



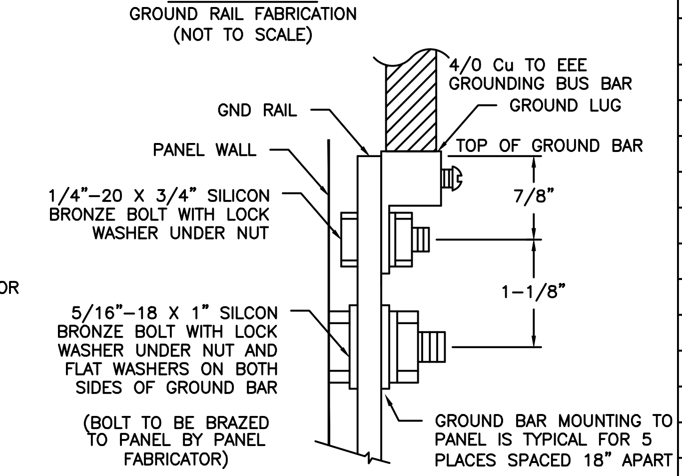
DETAIL 2
TERMINAL BLOCK MOUNTING
(NOT TO SCALE)



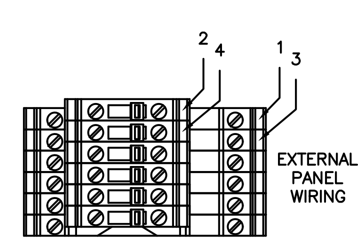
DETAIL 3
FUSE PLATE INDENTS
(NOT TO SCALE)



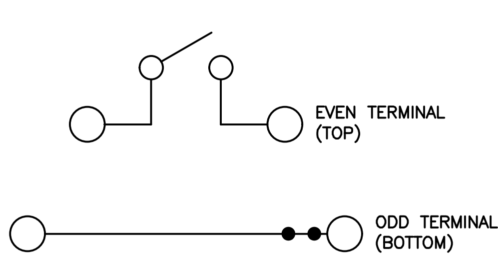
DETAIL 4
101/43RC CONTROL
SWITCH NAMEPLATE
(NOT TO SCALE)



DETAIL 8
PANEL GROUNDING LUG
(NOT TO SCALE)



DETAIL 5
KNIFE DISCONNECT
INSTALLATION DETAIL
(NOT TO SCALE)



DETAIL 6
KNIFE DISCONNECT
CIRCUIT DIAGRAM
(NOT TO SCALE)

MARK	QTY	DEVICE	MFGR.	TYPE	CATALOG NO.	RANGE	STORES	REMARKS
87VP, 87VS	2	CAPACITOR BANK VOLTAGE CONTROL PROTECTION RELAY	SEL	487V	0487V1X6151XB0X4H424XXX			
I/O A	1	ORION I/O	NOVATECH		I/O-SX-EP-411X-AD-WR 42-44-98			
	5	TEST SWITCH RACK ASSEMBLY	ABB	FT-19	FR3G000000000		6602412	
TS1/87VS, TS4/87VS, TS6/TSM, TS7/87VP, TS10/87VP, TS12/TSM	6	TEST SWITCH - 6C - 4P RACK MOUNTED	ABB	FT-19	R129A514G01		6602403	
TS2/87VS, TS3/87VS, TS8/87VP, TS9/87VP, TS11/87VP, TS13/86CP, TS14/86CS, TS15/86BF	8	TEST SWITCH - 10P RACK MOUNTED	ABB	FT-19	R129A501G01		6602404	
W	1	WHITE ILLUMINATING LIGHT	GE	ET-16 LED	116B6708G43W73W5		6646003	
101/43RC/@@K	1	BREAKER CONTROL SWITCH W/ ENGRAVING CODE: 123B-2B36A	ELECTRO	SERIES 24	88PDGRRX203FCLA		6650777	
86BF	1	BKR FAIL LOR W/ ENGRAVING CODE: 17C-2L22	ELECTRO	SERIES 24	7806D		6658201	
	1	BLUE HANDLE	ELECTRO	02000-11A-7				FOR 86BF
86CP, 86CS	2	CAPACITOR FAIL LOR W/ ENGRAVING CODE: 17C-2L22	ELECTRO	SERIES 24	7803D		6658207	
	2	ORANGE HANDLE	ELECTRO	02000-11A-2				FOR 86CP, 86CS
F/87VP, F/87VS, F/SC, F/SS, F/86BF, F/IOA, F/ANN, F/86CP, F/86CS	9	2-POLE FUSE HOLDER	MERSEN	ULTRASAFE	USCC2		3084990	
F/KPP, F/KPS, F/BPP, F/BPS, F/SST	5	3-POLE FUSE HOLDER	MERSEN	ULTRASAFE	USCC3		3084995	
	17	FUSE ANCHORS	PHOENIX	E/NS 35N	800886		6676506	FOR DIN-MOUNTED DEVICES
	22	10A FUSES	MERSEN	10A	ATMR10		3000110	
	2	6A FUSES	MERSEN	6A	ATMR6		3000106	
	7	3A FUSES	MERSEN	3A	ATMR3		3000103	
	2	1A FUSE	MERSEN	1A	ATMR1		3000101	
SAA, SAB, SAC, SAD	48 OR 64	KNIFE DISCONNECT S-TERMINAL BLOCKS	PHOENIX	UTTB-4-MT	3044775		6676505	
	3 OR 4	S-BLOCK END COVER	PHOENIX	D-UTTB 2.5/4	3047293			
	4 OR 5	S-BLOCK END CLAMP	PHOENIX	CLIPFIX 35-5	3022276			
	3 OR 4	TERMINAL STRIP MARKER CARRIER	PHOENIX	KLM 3	811969			
	1	MOUNTING RAIL - PHOENIX	PHOENIX	NS35/7.5	0801733		6676507	
	3 OR 4	TERMINAL BLOCK MARKER	PHOENIX	ZB 6, QR	1051029:0001			LABELED 1-10
	3 OR 4	TERMINAL BLOCK MARKER	PHOENIX	ZB 6, QR	1051029:0011			LABELED 11-20
	3 OR 4	TERMINAL BLOCK MARKER	PHOENIX	ZB 6, QR	1051029:0021			LABELED 21-30
	3 OR 4	TERMINAL BLOCK MARKER	PHOENIX	ZB 6, QR	1051029:0031			LABELED 31-40
A, B, C	168	A-B-C TERMINAL BLOCKS	AB		1492-CD3		6676500	
	3	A-B-C BLOCK END BARRIER	AB		1492-N16		6676501	
	6	A-B-C BLOCK END ANCHOR	AB		1492-N23		6676503	
	4	MOUNTING RAIL - ALLEN BRADLEY	AB		1492-N22		6676502	
	2	ALUMINUM MOUNTING CHANNEL	POWER STRUT		PS700J-10-AL			
LGND, RGND	2	1" X 1/4" X 76" COPPER GROUNDING RAIL					4596000	
	2	GROUND LUG	BURNDY		KA28			
WIREWAY	4	3" X 3" WIREWAY	PANDUIT		F3X3LG6		6630803	
	4	3" WIREWAY COVER	PANDUIT		C3LG6			
	1	12 1/4"x19" CONTROL SWITCH PLATE						
BLANK	1	1 3/4"x19" BLANK PANEL						
BLANK	1	3 1/2"x19" BLANK PANEL						
BLANK	3	5 1/4"x19" BLANK PANEL						
BLANK	1	7"x19" BLANK PANEL						
2" GROMMET	1	SNAP BUSHING FITS 2" HOLE	HEYCO		2400			
AC RECEPT	1	120VAC 20A DUPLEX RECEPTACLE	HUBBELL		HBL5362			
	1	HANDY BOX	APPLETON		180-1/2			
	1	RECEPTACLE COVER	APPLETON		180W			
	3	COAXIAL ADAPTERS, BNC (M-F-F)	LCOM		BA840		9401741	
	1	BNC FEMALE TO 2-WIRE BREAKOUT	LCOM		BC55			
TERM RESISTOR	1	BNC TERMINAL, 50-OHM TO RG-58 COAXIAL	AMPHENOL		RF 00-46650-51RFX			

KEYED DESIGN NOTES

1. VERIFY RELAY CONFIGURATION AND PART NUMBERS WITH MP RELAY ENGINEERING PRIOR TO ISSUING PRINT.
2. MODIFY TEST SWITCH TYPES & NAME TO SUIT CONTROL REQUIREMENTS.
3. INSTALL 1-SA BLOCK PER I/O CARD INSTALLED.
4. FILL IN BLANKS WITH INFORMATION FROM ENGINEERING M&R.
5. LEAVE AT LEAST 1RU BLANK BETWEEN I/O AND OTHER RACK EQUIPMENT FOR PANEL SIS WIRING.
6. FOR END OF IRIG CHAIN; OMIT IF IRIG CHAIN DOES NOT END AT THIS PANEL.
7. ADJUST END CLAMPS BASED ON PANEL'S DINRAIL-MOUNTED DEVICE CONFIGURATIONS. INCLUDE ONE CLAMP ABOVE AND BELOW EACH FUSE HOLDER.

REMOVE ALL KEYED DESIGN NOTES.
DELETE THE "Z-DESIGN (DELETE)" LAYER.

UNIQUE CHARACTER IDENTIFIERS

@@: ____________ CAP BANK NUMBER

REMOVE ALL UNIQUE CHARACTER IDENTIFIERS NOTES.

NOTES:

1. VENDOR SHALL MOUNT TERMINAL BLOCKS AT 45° ANGLE FROM WING PER DETAIL 2.
2. GROUND ALL CT'S AND CABLE SHIELDS ON GROUND RAIL.

NO.	DATE	REVISION DESCRIPTION	BY	APPROVED	NO.	DATE	REVISION DESCRIPTION	BY	APPROVED
A	03-08-23	MP STANDARDS - FINAL ISSUE	BSN/BV	PJK/BV	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.

DRAWN BY	.
APPROVED	.
DATE	.
SCALE	.

minnesota power
AN ALLETE COMPANY

115kV STANDARD
NO.@@ CAPACITOR BANK PANEL
ELEVATION & BILL OF MATERIALS

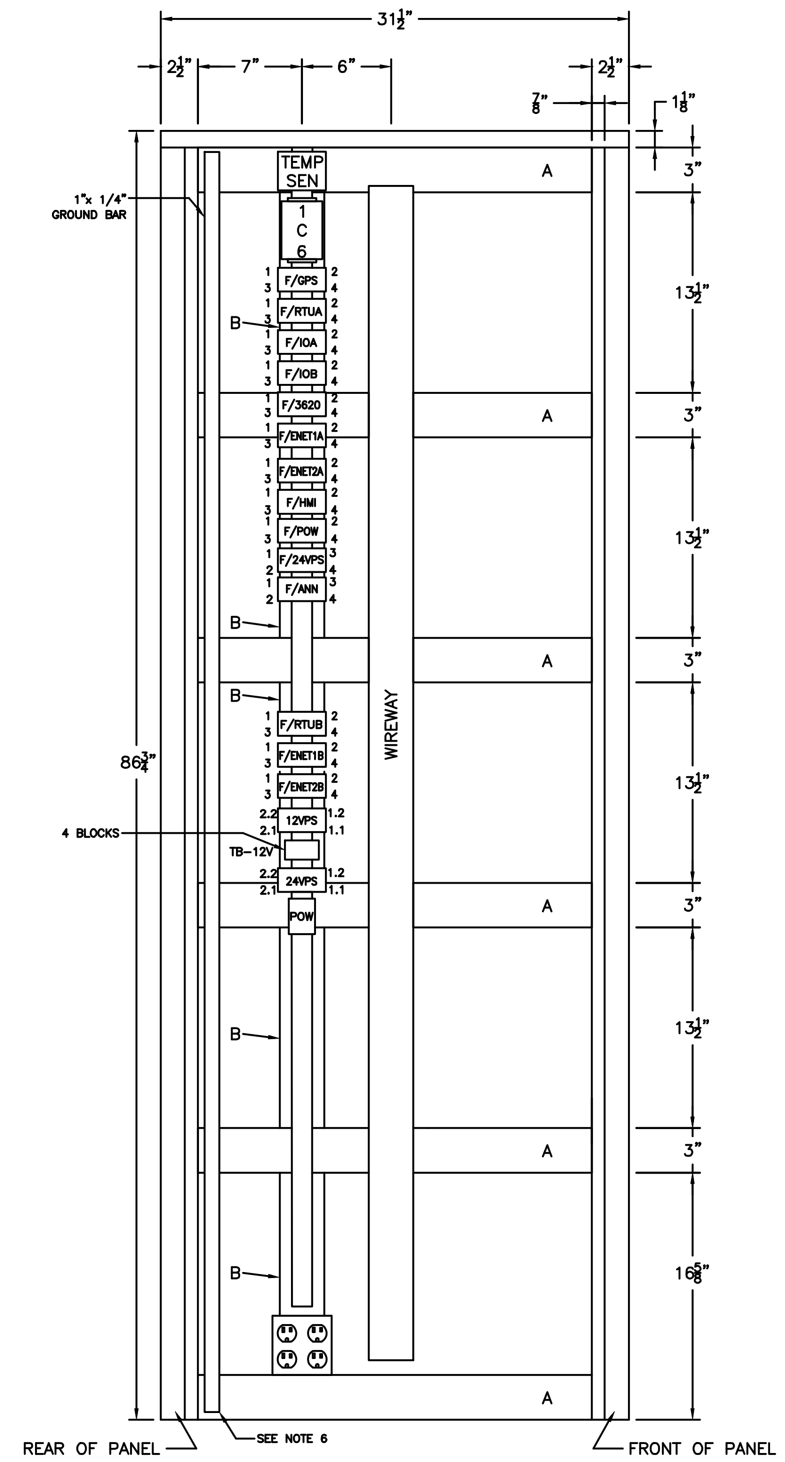
SHEET 1 REV. A

ME-35702-13

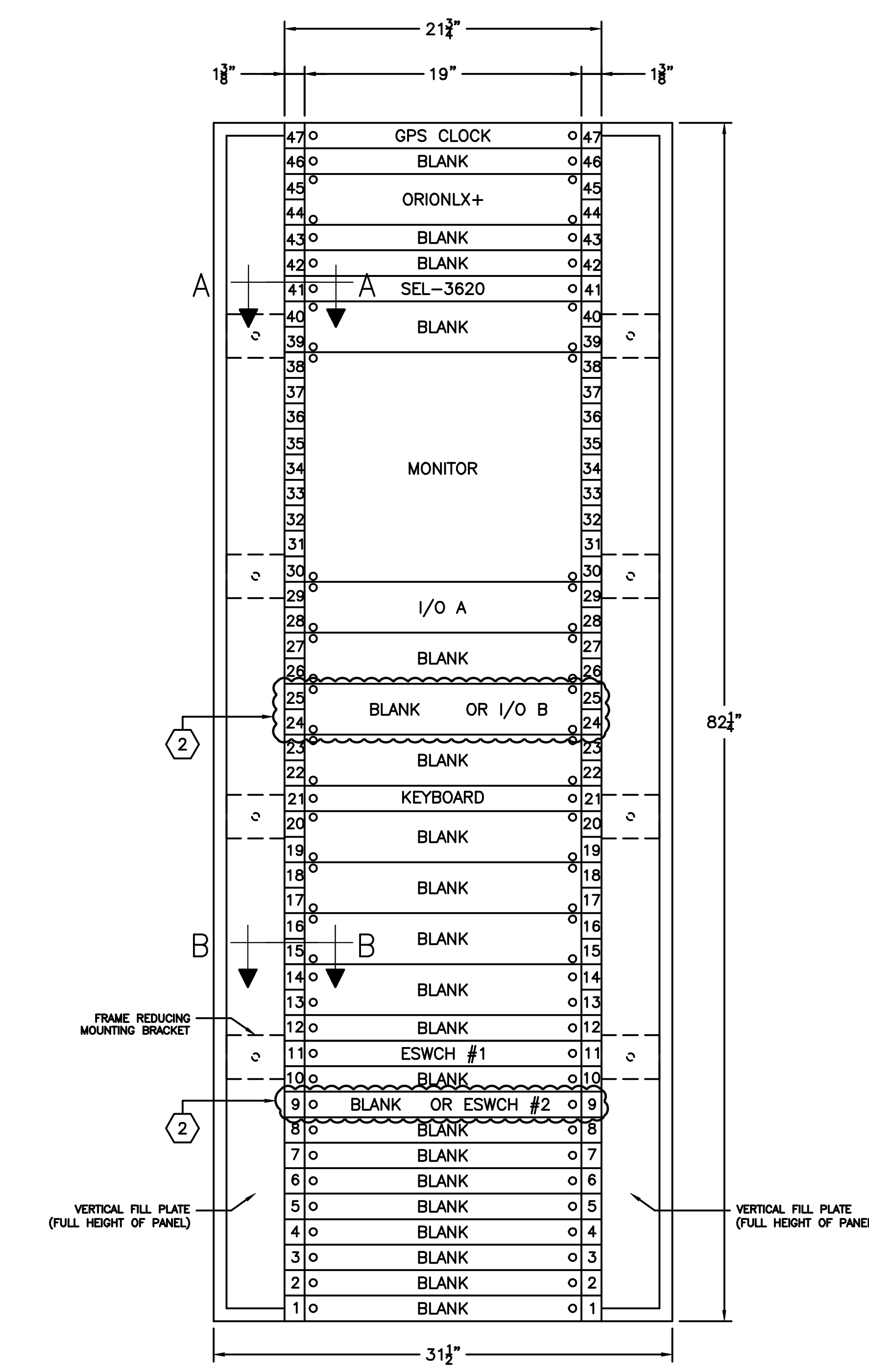
CADD DRAWING - FOR REPRODUCTION ONLY

MICROFILMED		CODE	
/ /	.	3200	3508

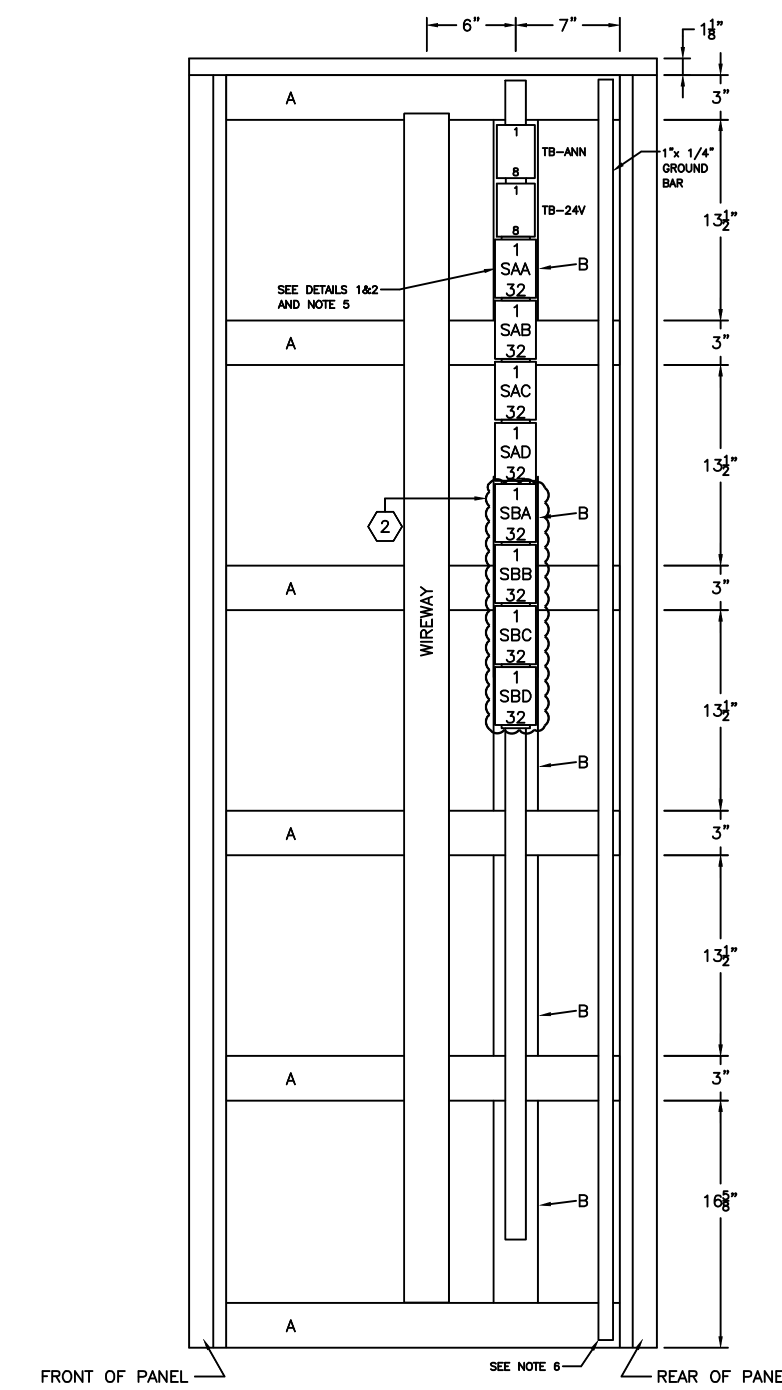
ImageSite: . .



LEFT WING

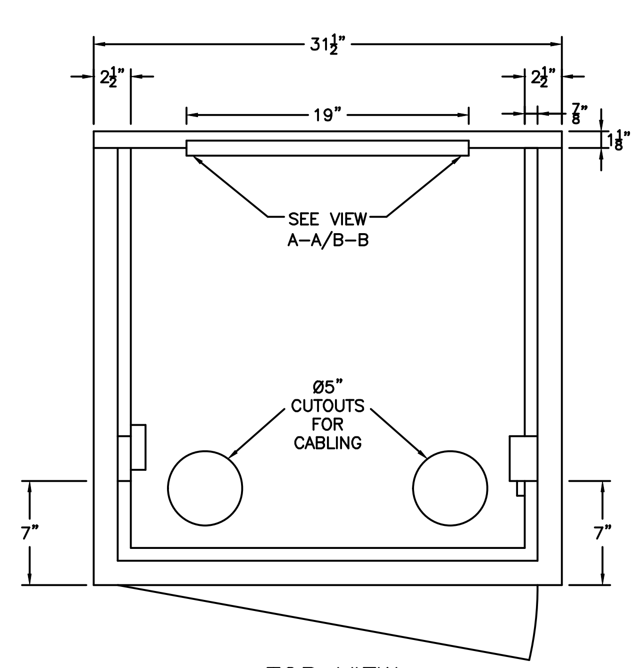


FRONT OF RACK

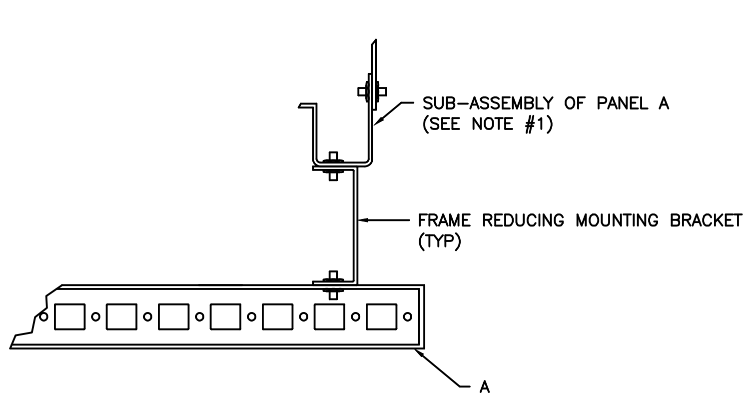


RIGHT WING

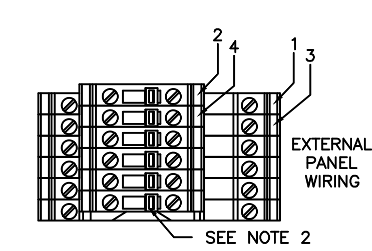
TOP VIEW
FRONT



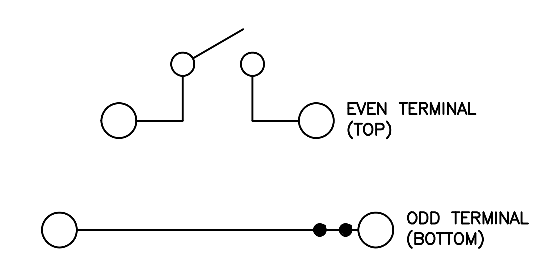
TOP VIEW
BACK



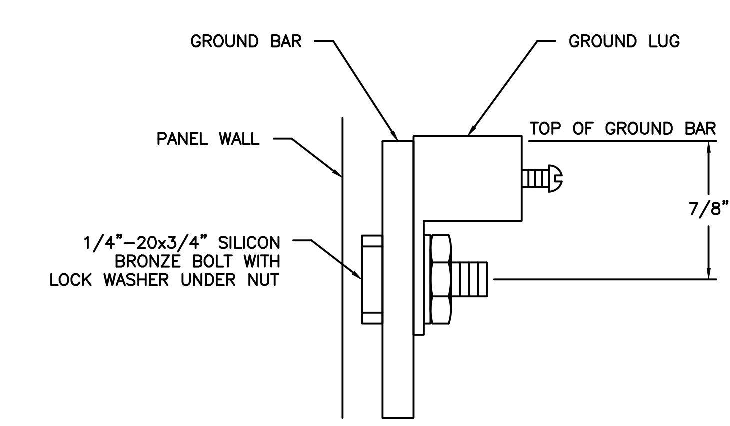
VIEW A–A &
VIEW B–B
(N.T.S)



DETAIL 1
KNIFE DISCONNECTS ARE ON EXTERNAL SIDE
(NOT TO SCALE)



DETAIL 2
TERMINAL BLOCK KNIFE DISCONNECT CIRCUIT DIAGRAM



DETAIL 3
PANEL GROUNDING LUG
(NOT TO SCALE)

NOTES:
1. FASTEN SUB ASSEMBLY PANEL A TO ADJUSTABLE RACK MOUNTING RAILS
2. PHOENIX PLUG-IN BRIDGES TO BE USED TO JUMPER ON ODD NUMBERED TERMINAL BLOCKS AND MARKED WITH PERMANENT INK TO IDENTIFY CONNECTED POINTS
3. SUB ASSEMBLY PANEL A TO BE MOUNTED FLUSH WITH DRESS FRAME
4. GROUND KIT TO BE USED TO GROUND DOOR TO PANEL AND SUB ASSEMBLY PANEL A TO PANEL.
5. 1 AND 32 ARE TERMINAL NUMBERS (NOT QUANTITY) EACH TERMINAL BLOCK HAS 2 TERMINALS PER DETAIL 1
6. DRILL AND TAP 10-32 HOLES AT 2" CENTERS

KEYED DESIGN NOTES (RTU PANEL)

(1) VERIFY DESIGN.

(2) ONE E-SWITCH AND ONE I/O TO BE INSTALLED STANDARD. INSTALL MORE OF EACH AS REQUIRED.

THESE DESIGN NOTES, HEX BLOCKS AND DESIGN CLOUDS ARE FOR ENGINEERING PURPOSES ONLY.
DRAFTER:
DELETE THE "Z-DESIGN (DELETE)" LAYER AND ALL KEYED DESIGN NOTES, HEXES AND ANY OPTIONS NOT USED (DOUBLE CHECK WITH ENGINEERS).

NO.	DATE	REVISION DESCRIPTION	BY	APPROVED	NO.	DATE	REVISION DESCRIPTION	BY	APPROVED
A	8-5-21	NEW DESIGN (ORION) RENAMED GE PANEL DRAWINGS	MRC	BAH	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.

DRAWN BY	MRC
APPROVED	BAH
DATE	4-1-21
SCALE	1 1/2"=1'-0"

minnesota power
AN ALLETE COMPANY

RTU PANEL STANDARD
ELEVATION

SHEET 1 REV. A

ME-35702-31

CADD DRAWING – FOR REPRODUCTION ONLY

MICROFILMED		CODE	
/ /	.	3200	3508

ImageSite: TRANSMISSION SUBSTATION

MARK	QTY	DEVICE	MFGR.	TYPE	CATALOG NO.	RANGE	STORES	REMARKS
	1	PROLINE SINGLE-BAY FRAME,2200x800x800mm	HOFFMAN	PRO-LINE	P2F2288			
	1	DRESS FRAME	HOFFMAN		P2DF228			FRONT OF PANEL
	1	SOLID DOOR, 2200 x 800MM	HOFFMAN		P2D228			MOUNT ON REAR OF PANEL
	1	PROLINE DATA POCKET (MOUNTED ON DOOR)	HOFFMAN		P2ADPS1			
	1	KEY LOCKING FLUSH HANDLE	HOFFMAN		PFHKBL			
	1	SOLID TOP, 800 X 800MM	HOFFMAN		P2T88			
	2	SOLID SIDES, 2200 X 800MM	HOFFMAN		P2CS228			
	1	SOLID BASE, 800 X 800MM	HOFFMAN		P2B088			
	1	LIFTING EYES (SET OF 4)	HOFFMAN		P2ALE			
	2	FRAME REDUCING BRACKETS (SET OF 4)	HOFFMAN		P2AFRB100			
	1	TAPPED HOLE, U-SHAPED RACK ANGLES, 2200MM (SOLD IN PAIRS)	HOFFMAN		P2RA19T22			
A	6	3-HOLE, 800MM GRID STRAPS (SOLD IN PAIRS)	HOFFMAN		P2G3R8			
B	5	3-HOLE, GRID STRAPS, 500MM (SOLD IN PAIRS)	HOFFMAN		P2GH3S5			
	1	RACK FILLER PANEL, TOP & BOTTOM	HOFFMAN		PFP19RA			
	1	CAGE NUT PACKAGE M6 (250)	HOFFMAN		PM6CN250			
	1	SCREW PACKAGE M6 (250)	HOFFMAN		ASM6250			
BLANK	9 OR 8	19" RACK PANEL – 2U	HOFFMAN		P19RP2UP			
BLANK	14 OR 13	19" RACK PANEL – 1U	HOFFMAN		P19RP1UP			
VERTICAL FILL PLATE	2	4" X 80" VERTICAL BLANK FILL PLATE						CUSTOM PLATE
	1	GROUNDING KIT	HOFFMAN		PGK-MC 46389			
	2	GROUNDING FASTENERS (PKG OF 20)	HOFFMAN		PGFGM6			
MONITOR	1	17" TOUCHSCREEN MONITOR	ELO		E326347			
	1	TOUCH SCREEN POWER BRICK	ELO		E005277			
	1	MONITOR RACK MOUNT BRACKET	ELO		E939253			
	1	DISPLAY PORT CABLE, 6'	TRIPPLITE		P580-006			
KEYBOARD	1	RACKMOUNT USB KEYBOARD/DRAWER WITH INTEGRATED TOUCHPAD	XYMPHONY		LCDK1016-N			
GPS CLOCK	1	GPS CLOCK	SEL	2407	24070003B		6650820	INCLUDES ANTENNA, CABLES, SURGE SUPPRESSOR & MOUNTING BRACKETS
		ANTENNA	SEL		SEL-9524A		6650821	
		ANTENNA MOUNTING KIT	SEL		915900043		6650822	
		GAS TUBE SURGE PROTECTOR	SEL		200-2005		6650823	
		GAS TUBE SURGE PROTECTOR MOUNTING BRACKET	SEL		200-2006		6650824	
F/HMI, F/ESWCH1A, F/ESWCH1B, F/ESWCH2A, F/ESWCH2B, F/RTUA, F/RTUB, F/IOA, F/IOB, F/3620, F/GPS, F/24VPS, F/ANN, F/POW	14	2 POLE FUSE HOLDER	MERSEN	ULTRASAFE	USCC2		3084990	
	2	3 AMP FUSE	MERSEN		ATMR3		3000103	
	26	1 AMP FUSE	MERSEN		ATMR6		3000101	
TB-24V, TB-ANN	2	P-TERMINAL BLOCK 2-INPUT, 16 OUTPUT	PHOENIX	VIP-2/SC/PDM-2/16	2315256			
TB-12V	4	KNIFE DISCONNECT TERMINAL BLOCKS	PHOENIX	UT 2,5-MT	3064069			
	1	ZACK MARKER STRIP	PHOENIX	ZB 5 CUS	0825011			
	1	END COVER	PHOENIX	D-UT 2,5/4-TWIN	3047141			
	2	END CLAMP	PHOENIX	CLIPFIX 35-5	3022276			
	2	PLUG-IN BRIDGE	PHOENIX	FBSR 3-8	3001597			
SAA, SAB, SAC, SAD, SBA, SBB, SBC, SBD	64 OR 128	KNIFE DISCONNECT TERMINAL BLOCKS	PHOENIX	UTTB 4-MT	3044775			
	4 OR 8	END COVER	PHOENIX	D-UTTB 2,5/4	3047293			
	5 OR 9	END CLAMP	PHOENIX	CLIPFIX 35-5	3022276			
	4 OR 8	TERMINAL BLOCK MARKER	PHOENIX	ZB 6 QR	1051029:0001			LABELED 1-10
	4 OR 8	TERMINAL BLOCK MARKER	PHOENIX	ZB 6 QR	1051029:0011			LABELED 11-20
	4 OR 8	TERMINAL BLOCK MARKER	PHOENIX	ZB 6 QR	1051029:0021			LABELED 21-30
	4 OR 8	TERMINAL BLOCK MARKER	PHOENIX	ZB 6 QR	1051029:0031			LABELED 31-40
	4 OR 8	TERMINAL STRIP MARKER CARRIER	PHOENIX	KLM 3	811969			1 FOR EACH S BLOCK, 1 FOR TB-12V
	2	MOUNTING RAIL	PHOENIX	NS35/7.5	0801733		6676507	
C	6	TERMINAL BLOCKS	AB		1492-CD3	600V, 35A	6676500	
	1	END BARRIER	AB		1492-N16		6676501	
	2	END ANCHOR	AB		1492-N23		6676503	
	1	MOUNTING RAIL	AB		1492-N22		6676502	

MARK	QTY	DEVICE	MFGR.	TYPE	CATALOG NO.	RANGE	STORES	REMARKS
ORIONLX+	1	ORIONLX+ SUBSTATION RTU	NOVATECH	6	ORIONLX+-E7-PBB-MMC-HVHV-04-07-14-37-47-49-52-35-57-93-95-97-99-108	3		
3		(E7) – QTY 7 ISOLATED RS-232 CARD WITH IRIG-B						
		(PBB) – PORT B: RS-422/485 CARD						
		(MMC) – MULTIMEDIA CARD WITH DISPLAY & AUDIO PORTS						
		(HV) – 100-300V DC / 85-264V AC POWER SUPPLY						
		(HV) – REDUNDANT 100-300V DC / 85-264V AC POWER SUPPLY						
6		(04) – MODBUS SERIAL MASTER						
		(07) – MODBUS TCP MASTER						
		(14) – SEL ASCII/FAST MESSAGING						
6		(47) – MODBUS SERIAL SLAVE						
		(49) – MODBUS TCP SLAVE						
		(37) – SEL TCP						
		(52) – PUSHER						
		(57) – WEBSERVER XML						
		(35) – LOGICPAK						
		(95) – ALARM/ARCHIVE/RETENTIVE						
		(97) – CASCADED ORIONS MASTER						
		(99) – ADVANCED MATH AND LOGIC						
		(108) – TILE ANNUNCIATOR						
I/O A	1	ORION I/O	NOVATECH		ORION I/O-SX-EP-6113-AD-WR-42-44-98		9204210	
		(SX) – STANDARD ONE SERIAL RS-232/485 PORT ONLY						
		(EP) – ONE COPPER PORT, ONE SFP PORT						
		(6) – 8 AI FLEX CARD						
		(1) – 16 DI CARD						
		(1) – 16 DI CARD						
		(3) – WETTED 16 DI CARD						
		(AD) – ADVANCED USER INTERFACE						
		(WR) – STANDARD 48-250V DC AND 69-240V AC NOMINAL						
		(42) – DNP3 SERIAL SLAVE						
		(44) – DNP3 IP SLAVE						
		(98) – CASCADED ORIONS SLAVE						
I/O B	1	ORION I/O	NOVATECH		ORION I/O-SX-EP-411X-AD-WR-42-44-98		9204212	
2		(SX) – STANDARD ONE SERIAL RS-232/485 PORT ONLY			5			
		(EP) – ONE COPPER PORT, ONE SFP PORT						
		(4) – 16 DO HPO						
		(1) – 16 DI CARD						
5		(1) – 16 DI CARD						
		(X) – EMPTY						
		(AD) – ADVANCED USER INTERFACE						
		(WR) – STANDARD 48-250V DC AND 69-240V AC NOMINAL						
		(42) – DNP3 SERIAL SLAVE						
		(44) – DNP3 IP SLAVE						
		(98) – CASCADED ORIONS SLAVE						
ESWCH #1, ESWCH #2	1 OR 2	ETHERNET SWITCH 2	RUGGEDCOM	RST2228	6GK6222-6AB00-5CC0-Z A01+B01+C01+D01+E01+F01+G01		9201236	4
XXX-XXX-E-SWCH-1, XXX-XXX-E-SWCH-2	1 OR 2	ETHERNET SWITCH	CISCO		CGS-2520-24TC			
	2 OR 4	HIGH AC/DC POWER SUPPLY FOR CISCO 2520	CISCO		PWR-RDG-AC-DC	4 2		
SEL-3620	1	ETHERNET SECURITY GATEWAY	SEL		3620XHAOXXX0		6659036	
24VPS	1	24VDC POWER SUPPLY	PHOENIX	MINI-PS	2904598	OUTPUT: 24VDC, 2.5A	4200115	
12VPS	1	12VDC POWER SUPPLY	PHOENIX	MINI-PS	2904605	OUTPUT: 12VDC, 2.5A	4200120	
TEMP SENSOR	1	WALL MOUNT TEMP SENSOR	OMEGA		EWS-TX M3500/0514		9203185	
WIREWAY	2	3" X 3" WIREWAY	PANDUIT		F3X3LG6			
	2	3" WIREWAY COVER	PANDUIT		C3LG6			
AC RECPT	2	125VAC, 20A DUPLEX RECEPTACLE	HUBBELL		HBL5362			
	1	HANDY BOX	APPLETON		4SPD			
	1	OUTLET COVER	APPLETON		8371N			
	2	1" x 1/4" COPPER GROUNDING BAR					4596000	
	2	GROUND LUG	BRUNDY		KA28			
	3	COAX F ADAPTER	LCOM		BA840		9401741	
2	1	BNC FEMALE CONNECTOR W/LEADS	LCOM		BC55		9401742	
TERM RESISTOR	1	BNC TERMINATOR, 50 OHMS, 1 WATT	AMPHENOL RF		000-46650-51RFX			

MARK	QTY	DEVICE	MFGR.	TYPE	CATALOG NO.	RANGE	STORES	REMARKS
POW	1	DC TO DC TRANSMITTER	API		API4300GD	0-175VDC 0-1mA		
	1	8-PIN SOCKET	API		API008			

KEYED DESIGN NOTES (RTU PANEL)

1. VERIFY DESIGN.
2. ONE E-SWITCH AND ONE I/O TO BE INSTALLED STANDARD. INSTALL MORE OF EACH AS REQUIRED.
3. SEVEN RS-232 PORTS TO BE INSTALLED STANDARD. INSTALL ADDITIONAL SERIAL PORTS IF NEEDED. REMOVE PORT B IF RS-485 IS NOT NEEDED
4. RUGGEDCOM ETHERNET SWITCHES TO BE USED FOR LOW IMPACT NERC CIP SITES. CISCO ETHERNET SWITCHES TO BE USED FOR MEDIUM IMPACT SITES (UPDATE DEVICE NAME THROUGHOUT DRAWINGS).
5. POPULATE ADDITIONAL I/O SLOT OPTIONS FROM STANDARD MP CONFIGURATIONS AS NEEDED FIRST (6113, 411X, 4111) IF SPECIALIZED I/O IS NEEDED CONSULT WITH MP ENGINEERING
6. INCLUDE ONLY MODBUS PROTOCOL OPTIONS THAT ARE REQUIRED BY PROJECT (EX. MODBUS SERIAL INTERFACE TO CUSTOMER).

THESE DESIGN NOTES, HEX BLOCKS AND DESIGN CLOUDS ARE FOR ENGINEERING PURPOSES ONLY.
DRAFTER:
DELETE THE "Z-DESIGN (DELETE)" LAYER AND ALL KEYED DESIGN NOTES, HEXES AND ANY OPTIONS NOT USED (DOUBLE CHECK WITH ENGINEERS).

NO.	DATE	REVISION DESCRIPTION	BY	APPROVED	NO.	DATE	REVISION DESCRIPTION	BY	APPROVED
A	8-5-21	NEW DESIGN (ORION) RENAMED GE PANEL DRAWINGS	MRC	BAH	.	.	.	.	.
B	5-9-22	UPDATED ORION I/O A & B	MRC	DPJ	.	.	.	.	.
C	10-26-22	CHANGED RUGGED ENTHERNET SWITCHES	MRC	ART/DPJ	.	.	.	.	.

DRAWN BY	MRC
APPROVED	BAH
DATE	4-1-21
SCALE	NONE

minnesota power
AN ALLETE COMPANY

RTU PANEL STANDARD
BILL OF MATERIAL

SHEET 2 REV. C

ME-35702-31

ImageSite: TRANSMISSION SUBSTATION

CADD DRAWING – FOR REPRODUCTION ONLY

MICROFILMED / /

CODE 3200 3508

[Site]

[Project]

MINNESOTA POWER

STANDARD EQUIPMENT SPECIFICATION

CONTROL PANELS

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Signature:___________________________________

Typed or Printed Name: XXX
Date: XXXX XX, 20XX License No.: XXXX

Date	Prep
11/06/2023	SDK

Standard Number

PN01PA

(Rev 4)

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1. STANDARDS

2. GENERAL CONSTRUCTION

2.1 The panel enclosure shall be constructed per Minnesota Power Steel Detail drawings as outlined in Section 14.

2.2 Panel enclosure, 19” rack mounted control plate, and “blanks” shall be 10 or 11 gauge steel.

2.3 The panel shall be fabricated with no welds, rivets or bolt heads visible from the outside.

2.4 Each piece of equipment shall be mounted and wired so that removal and replacement may be accomplished without interruption of adjacent devices.

2.5 All devices to be located as shown on Purchaser’s elevation drawings. Any deviation requires written approval from Purchaser Relay and Control Engineering.

2.6 The drawings listed in Section 14 are attached to and form part of this specification:

2.7 Purchaser provides the Supplier with wiring schematics for fabrication.

2.7.1 If the Supplier requires wiring diagrams to complete construction of the panels it is the responsibility of the Supplier to take the Purchaser provided wiring schematics and develop the wiring diagrams. The wiring diagrams will need to be approved by the purchaser.

2.7.2 During the bid process Purchaser can, upon request, provide an example of Purchaser’s wiring schematics.

3. DESIGN DETAILS

3.1 The mounting position of indicating lights and control switches is critical to the purchaser's identification decals.

3.2 Control switch mounting centerlines should be approximately 42.5 inches above the floor or as specified on the elevations.

3.3 Equipment mounted on the inside of the panel shall be mounted on unistrut, attached to the panel, or the panel may be drilled and tapped to accept screws which shall be flush to the outside of the panel.

3.4 Purchaser's cables will come in from the top of the panel, usually landing on the left wing of the panel as viewed from the rear of the panel. SCADA cables will come in from the top and are landed on the right wing S blocks as viewed from the rear of the panel.

3.5 Termination blocks shall be mounted at a 45 degree angle from the wing as viewed from the rear of the panel.

3.6 Interior panel wiring shall be landed on the right side of terminal blocks located on the left wing and on the left side of terminal blocks located on the right wing as viewed from the rear of the panel or as specified on purchaser's termination block layout drawings.

3.7 S Terminal Blocks shall be mounted with the disconnect switch towards the rear of the panel. Plug-in bridges shall be used for jumpers between S Terminal Blocks. The bridges shall be marked with permanent black ink to indicate bridge configuration when installed.

3.8 9/16" diameter holes shall be provided near each corner of the bottom frame for anchoring the panel to the floor.

3.9 Lifting provisions shall be provided on the top of the panel.

3.10 Plastic wire trough will be supplied by the Supplier and mounted on the wing of the panel for routing and connecting wires were applicable.

3.11 The following information shall be supplied on the rear surface of each panel where it will be visible after assembly:

3.11.1 Substation Name

3.11.2 Purchase Order Number

3.11.3 Supplier's Name

3.11.4 Suppliers' Shop Order Number

3.12 Each terminal block, terminal, conductor, relay, breaker, fuse block, and other auxiliary devices excluding test switches shall be permanently labeled on the back and front of the panel, where applicable to coincide with the identification indicated on the Purchaser's drawings.

3.13 Terminal blocks shall be marked with white marking strips and permanent black ink.

4. INSPECTION

4.1 All work performed shall be subject to inspection. The Purchaser shall have the right to visit the Supplier's plant at any time.

5. PAINTING

5.1 All metal parts shall be cleaned and bonderized, followed immediately by a prime coat of rust resistant paint.

5.2 The control panel finish exterior color shall be ANSI-61 gray.

5.3 The control panel interior color shall be white.

6. CONTROL WIRING

6.1 All wiring shall be free of abrasions and tool marks.

6.2 Terminals interconnected by a solid line on wiring schematics are to be interconnected exactly as shown. Terminals interconnected by a dotted line on wiring schematics are to be interconnected via the shortest route. **The supplier shall follow the sequence provided on the wiring schematics or mark-up the wiring schematics indicating the sequence in which the circuit was wired.**

6.3 All wiring to devices shall come from nearest top or bottom edge. This will keep the back of devices clear between mounting studs for future mounting of other equipment.

6.4 Provide type SIS extra flexible stranded tinned-copper control wire rated 600V for panel wiring.

6.4.1 SIS Conductor Insulation shall be 90°C Rated.

6.5 All current transformer (CT) circuits used for tie or revenue metering are to be wired with #10 AWG wire. All other CT circuits are to be wired with #12 AWG wire.

6.6 All control circuits are to be wired with #14 AWG. An exception will be allowed when factory specification cable sizes are smaller than #14 AWG. The largest factory specification cable size will be used in those instances.

6.7 Alarm circuits are to be wired with #16 AWG wire.

6.8 RTU circuits are to be wired with #18 AWG wire.

6.9 Uninsulated ring tongue lugs shall be used for all terminations except where compression terminals exist.

6.9.1 All compression terminals, terminate wiring using single and twin insulated ferrules. All insulated ferrules shall be sized properly for the wire they are being terminated on to manufacture specification.

6.10 No more than two wires shall be terminated on a given terminal block point.

6.11 The conductors shall be bundled, routed and secured in a manner that will not obstruct additional wiring that could be installed by the Purchaser to the terminals of Fabricator installed components.

6.12 Splices are not permitted in control wiring or instrument leads.

7. ELECTRICAL TESTS

7.1 Each circuit shall be given a continuity test after the panel is completely wired.

7.2 Perform any Supplier's acceptance tests for each of the relays and devices.

7.3 Check relays to ensure that all internal AC and DC voltage taps are at proper settings as applicable.

7.4 Using the panel schematics as a reference, apply AC voltages and currents to the Voltage Transformer (VT) and CT circuits from a test source.

7.4.1 Record readings and outputs of meters, recorders, transducers, etc.

7.4.2 Apply voltage and current of proper phase and magnitude to cause all devices to operate under simulated field conditions.

7.4.3 Allow sufficient time for devices to reach normal operating temperature.

7.4.4 Check all devices for abnormal heating.

7.5 Using schematics as a reference, apply DC voltage from a test source to the DC circuits.

7.5.1 Where a circuit breaker or other external device is shown, connect a mock device or DC test board to simulate the external device.

7.5.2 Operate all DC circuits to simulate field conditions, causing devices to trip or function as designed.

7.5.3 Check relay targets, coils, contacts, etc. for correct operation. Verify electro-mechanical relay targets are consistent with test applied.

7.5.4 Check timing relays for correct sequence and operation.

7.6 The tests specified in this section shall be performed in accordance with all applicable standards. The results of all tests and supporting data shall be included in the final test report.

8. <u>SHIPMENT</u>

8.1 The Supplier shall prepare all equipment covered by this specification for shipment in such a manner as to protect it from damage in transit.

8.2 Any and all damage resulting from improper preparation shall be repaired or replaced at the Supplier's expense.

9. <u>DOCUMENT SUBMITTAL</u>

9.1 All drawings for submittal should be sent electronically to:

[Engineer Name]
[Engineer Email]

9.2 All submittals are to include one (1) paper copy or one (1) electronic set in AutoCad or compatible drawing format approved by the Purchaser.

9.3 Supplier to fill in attached (PN01PA – Section 9.3Panel Schedule) within one week of receipt of order.

9.4 Dimensioned elevations and section drawings are required for approval within two weeks of receipt of order. Catalog numbers of the panel equipment are to be included with this submittal.

9.5 Steel Fabrication drawings are required for approval within two weeks of receipt of order.

9.6 If Supplier will be developing wiring diagrams per Section 2.7.1, the wiring diagrams are required for approval within two weeks after the receipt of schematics from the Purchaser.

9.7 Redlined as constructed Purchaser's wiring schematics for each panel are required with shipment of the panel. As-builts drawings shall be printed with color on 18x24" paper.

9.8 Record drawings are required within two weeks of panel shipment. Record drawings to include the following:

9.8.1 Final drawings from Section 9.4, 9.6, and 9.7.

9.8.2 Copy of the final test reports

10. INSTRUCTION MANUALS

10.1 Supplier shall provide:

10.1.1 One (1) set of instruction manuals bound per panel at time of panel shipment.

10.1.2 Two (2) CD's containing electronic versions of all documentation shall be included with instruction manuals at time of panel shipment.

10.2 The set of instruction manuals shall contain manufacturer's literature for each device as specified on the front elevation drawings.

11. INFORMATION REQUIRED WITH QUOTATION

11.1 Shipping cost for the panels is to be included [in each panel cost.] [in the shipping cost for the associated Electrical Equipment Enclosure (EEE)]. Price F.O.B. destination.

11.2 Delivery Date

11.2.1 Desired delivery date is no later than [Date]

11.3 Date wiring schematics are required from the purchaser.

11.4 Exceptions to these specifications

11.5 Complete Bill of Materials

11.6 Quality Control Checklist

11.7 Completed price breakdown, see attached (PN01PA – Section 11.7 Bid Tab)

12. QUALITY SYSTEM REQUIREMENTS

12.1 VERIFICATION

12.1.1 The Purchaser shall have access to perform assessments, quality audits, or witness test activities during the manufacturing process and to review applicable records. Purchaser may designate an authorized agent to perform these activities. The authorized agent may be an employee of the Purchaser or an outside agency. When an outside agency is designated as an authorized agent for the Purchaser, such designation shall be in writing with a copy provided to the Supplier. Hereinafter, when the term "Purchaser's representative" is used, it may also mean the Purchaser or the authorized agent.

12.1.2 The following requirements apply for Purchaser's inspection at the Supplier's mill, factory, yard, warehouse, or subtier supplier's facilities.

12.2 ACCESS

12.2.1 The Purchaser shall have the right to access the Supplier's and subtier supplier's work and related documents at any time during the manufacturing process without delaying the schedule. The Supplier shall provide, without cost, reasonable facilities including tools, personnel, and instruments for demonstrating acceptability of the work.

13. REVISION TABLE

Number	Date	By	Reviewed	Description
0	04/6/2018	BAH	BAF	1. Updated Format, reset Revision Number to 0 2. Added S-Block Mounting Info 3. Added #10 AWG requirement for Metering CT Circuits 4. Clarified Wiring Schematic vs Wiring Diagram requirements and responsibilities
1	10/3/2018	BAH	DJS, SLM, BAF, KJR	1. Changed Control Wiring Size to #12 2. Added Requirement for SIS Insulation rating of 90°C
3	7/26/2022	TJC	DPJ	1. Added PE signature block to the front page.
4	11/6/2023	SDK	Control Meeting BAH, SP, NE, DJ	1. 6.6 added exception and changed #12 AWG to #14 AWG for control wiring. 2. 6.9 Changed RTU to All for compression terminals

14. ATTACHED DRAWINGS

DRAWING #	DRAWING NAME	STEEL DETAIL DRAWING
ME-XXXXX-XX SH. X	*[Communications Panel]*	*N/A*
ME-XXXXX-XX SH. X	*[Metering Panel/Cabinet Panel]*	*MB+19414-02 SH.XX*
ME-XXXXX-XX SH. X	*[Sync Panel Panel]*	*MB+19414-03 SH.XX*
ME-XXXXX-XX SH. X	*[Termination Cabinet]*	*N/A*
ME-XXXXX-XX SH. X	*[RTU Panel]*	*N/A*
ME-XXXXX-XX SH. X	*[HMI Panel]*	*N/A*
ME-XXXXX-XX SH. X	*[XXkV Bus Differential Panel]*	*MB+19414-02 SH.XX*
ME-XXXXX-XX SH. X	*[DFR Panel]*	*MB+19414-02 SH.XX*
ME-XXXXX-XX SH. X	*[X Transformer Panel]*	*MB+19414-02 SH.XX*
ME-XXXXX-XX SH. X	*[XX Line Panel]*	*MB+19414-02 SH.XX*
ME-XXXXX-XX SH. X	*[XX Capacitor Bank Panel]*	*MB+19414-02 SH.XX*
ME-XXXXX-XX SH. X	*[XX Feeder Panel]*	*MB+19414-02 SH.XX*

Site

Project

MINNESOTA POWER

STANDARD EQUIPMENT SPECIFICATION

DISTRIBUTION PANEL

250 VOLT DC

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Signature:____________________________________

Typed or Printed Name: Name Here
Date: January 1, 2018 License No.: #####

Date	Prep
XX/XX/XX	XXX

Standard Number

PN02PA

(Rev 0)

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1. SCOPE

This specification sets forth the minimum technical requirements for an electric distribution panel of 250 volts DC to be provided to Minnesota Power (Purchaser) by the Supplier. The Supplier shall quote in strict conformance with these specifications. All exceptions to these specifications or any required standard shall be stated and explained in the submitted proposal.

Section 9.1 can be used to look up drawing numbers for references to Purchaser's drawings contained in this specification.

Delivery of the panel is required by [MM,DD,YYYY].

2. STANDARDS

The apparatus shall be designed, manufactured and tested in accordance with the latest revision of the following:

2.1 National Electric Safety Code (NESC) (IEEE C2)

2.2 National Electric Code (NEC) as amended and adopted by the state in which the panel will be installed.

2.3 All other applicable or jurisdictional Codes and Standards (ex. ANSI, IEC, NEMA, ASTM, ICEA, IEEE, NFPA, UL, etc.)

3. GENERAL DESCRIPTION

3.1 The panel shall be rated 250 volts DC, 2 Wire for use on a 130 Volt DC System.

3.2 The main bus shall be one piece continuous tin or silver plated copper rated [XXX]A.

3.3 The minimum short circuit rating of the bus and breakers shall be [XX]kA.

4. ENCLOSURE

4.1 The enclosure shall be NEMA class [1, 2, 3, 3R or 4] construction.

4.2 The box shall be without knockouts.

4.3 The minimum wireway space shall be as follows: Sides 3 inches; Top and bottom 5 inches. The box depth shall be a minimum of 5 1/2 inches.

4.4 The enclosure shall be a maximum of 80 inches high.

4.5 The enclosure shall be [surface/flush] mounting.

4.6 The exterior and interior paint shall be ANSI 61 gray.

4.7 The box shall have welded seams throughout.

5. MAIN BREAKER

5.1 Provide [value] ampere, 250 volts DC, 2 Pole main breaker.

5.2 The interrupting capacity of the main breaker shall be as listed in Section 3.3.

5.3 The main breaker or main lugs shall be [top/bottom] feed and suitable for [1, 2, or 3, value] AWG/kcmil copper cable per pole.

5.4 Provide feed through lugs, same ampacity as main bus.

6. BRANCH CIRCUITS

6.1 Provide subfeed lugs, [value] ampere capacity.

6.2 All branch circuit breakers will be thermal magnetic unless noted otherwise and rated 250 volts DC.

6.3 All branch breakers shall be bolt on style.

6.4 All branch breakers shall have an interrupt rating as listed in Section 3.3.

6.5 The branch circuit breakers shall meet or exceed UL, E-11592, NEC latest issue, NEMA standard AB1, and Federal specifications WC-375A.

6.6 [The circuit breakers shown on the 125V DC Distribution Diagram shall be included as part of this DC Panel./The following circuit breakers as indicated below shall be included as part of this DC Panel:]

Quantity	Continuous Amps	Mag Trip Only	Adj Mag Trip

7. ALTERNATE

7.1 Provide an alternate for a 125 volt DC pilot light.

7.2 Provide gasketed doors and fronts.

7.3 Provide an alternate for a panel rating including branches of [value] amperes short circuit symmetrical/asymmetrical.

8. REVISION TABLE

Number	Date	By	Reviewed	Description
0	12/11/2019	BAH		Reformat of existing PN03PA Spec, Changed section numbering, Reset Revision to 0.

9. ATTACHMENTS AND DRAWINGS

9.1 The following drawings are referenced in the above specifications and include the panel that is to be provided by the Supplier.

Drawing #	Drawing Name
[ME-XXXXX-XX SHX]	[Drawing Title]
[ME-XXXXX-XX SHX]	[Drawing Title]
[ME-XXXXX-XX SHX]	[Drawing Title]
[ME-XXXXX-XX SHX]	[Drawing Title]

Site

Project

MINNESOTA POWER

STANDARD EQUIPMENT SPECIFICATION

DISTRIBUTION PANEL

600 VOLTS OR LESS AC

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Signature:___________________________________

Typed or Printed Name: Name Here
Date: January 1, 2018 License No.: #####

Date	Prep
XX/XX/XX	XXX

Standard Number

PN03PA

(Rev 0)

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9. REVISION TABLE 3

10. ATTACHMENTS AND DRAWINGS 4

1. SCOPE

This specification sets forth the minimum technical requirements for an electric distribution panel of 600 VAC or less to be provided to Minnesota Power (Purchaser) by the Supplier. The Supplier shall quote in strict conformance with these specifications. All exceptions to these specifications or any required standard shall be stated and explained in the submitted proposal.

Section 10.1 can be used to look up drawing numbers for references to Purchaser's drawings contained in this specification.

Delivery of the panel is required by [MM,DD,YYYY].

2. STANDARDS

The apparatus shall be designed, manufactured and tested in accordance with the latest revision of the following:

2.1 National Electric Safety Code (NESC) (IEEE C2)

2.2 National Electric Code (NEC) as amended and adopted by the state in which the panel will be installed.

2.3 All other applicable or jurisdictional Codes and Standards (ex. ANSI, IEC, NEMA, ASTM, ICEA, IEEE, NFPA, UL, etc.)

3. GENERAL DESCRIPTION

3.1 The panel shall be rated:

3.1.1 120/240 volts AC, single phase, three wire for use on a 120/240 volt, single phase three wire system.

3.1.2 240 volt AC, three phase, four wire for use on a 240 volt AC three phase, four wire, midpoint grounded delta system, or 120/208 volt AC three phase, four wire, grounded wye system.

3.1.3 240 volt AC, three phase, three wire for use on a three phase, three wire, grounded "B" phase system.

3.1.4 480 volt AC, three phase, four wire, for use on a three phase, four wire, midpoint grounded delta, or a three phase, four wire, 277/480 volt AC grounded wye system.

3.2 The main bus shall be rated [XXX] ampere, and one piece continuous tin or silver plated copper.

3.3 The minimum symmetrical/asymmetrical short circuit rating of the bus and breakers shall be [XX,XXX] amperes.

4. ENCLOSURE

4.1 The enclosure shall be NEMA class [1, 2, 3, 3R or 4] construction.

4.2 The box shall be without knockouts.

4.3 The minimum wireway space shall be as follows: Sides 4 1/2 inches; Top and bottom 7 inches. The box depth shall be a minimum of 5 1/2 inches.

4.4 The enclosure shall be a maximum of 80 inches high.

4.5 The enclosure shall be [surface/flush] mounting.

4.6 The exterior and interior paint shall be ANSI 61 gray.

4.7 The box shall have welded seams throughout.

5. MAIN BREAKER

5.1 Provide [value] ampere, [1 or 3] phase, [3 or 4] wire value volt AC, main lugs only.

5.2 Provide [value] ampere, [1 or 3] phase, [3 or 4] wire value volt AC, main breaker, bolt on style.

5.3 The main breaker shall have an adjustable magnetic trip range of [value] amperes.

5.4 The interrupting capacity of the main breaker shall be as listed in Section 3.3.

5.5 The main breaker or main lugs shall be [top/bottom] feed and suitable for [1, 2, or 3, value] AWG/kcmil copper cable per pole.

5.6 Provide feed through lugs, same ampacity as main bus.

6. BRANCH CIRCUITS

6.1 Provide subfeed lugs, [value] ampere capacity.

6.2 All branch circuit breakers will be thermal magnetic unless noted otherwise and rated [value] volts AC.

6.3 All branch breakers shall be bolt on style.

6.4 All branch breakers shall have an interrupt rating as listed in Section 3.3.

6.5 The branch circuit breakers shall meet or exceed UL, E-11592, NEC latest issue, NEMA standard AB1, and Federal specifications WC-375A.

6.6 The following circuit breakers as indicated below shall be included as part of this AC Panel:

Quantity	Continuous Amps	No. Poles	Mag Trip Only	Adj Mag Trip	GFI Breaker

7. NEUTRAL CONNECTION

7.1 Provide a [value] ampere solid neutral connection lug.

8. ALTERNATE

8.1 Provide a green 120 volt AC pilot light with control power transformer when necessary.

8.2 Provide gasketed doors and fronts.

9. REVISION TABLE

Number	Date	By	Reviewed	Description
0	12/11/2019	BAH		Reformat of existing PN03PA Spec, Changed section numbering, Reset Revision to 0.

10. ATTACHMENTS AND DRAWINGS

10.1 The following drawings are referenced in the above specifications and include the panel that is to be provided by the Supplier.

Drawing #	Drawing Name
[ME-XXXXX-XX SHX]	[Drawing Title]
[ME-XXXXX-XX SHX]	[Drawing Title]
[ME-XXXXX-XX SHX]	[Drawing Title]
[ME-XXXXX-XX SHX]	[Drawing Title]

Site

Project

MINNESOTA POWER

STANDARD EQUIPMENT SPECIFICATION

LEAD STORAGE BATTERY

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Signature:_______________________________________

Typed or Printed Name: Name Here
Date: January 1, 2018 License No.: #####

Date	Prep
XX/XX/XX	XXX

Standard Number

SB01PA

(Rev 0)

Table of Contents

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4. ACCESSORIES 1

5. INFORMATION REQUIRED SWITH PROPOSAL 2

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8. SHIPMENT 3

9. TABLES 4

10. REVISION TABLE 4

11. ATTACHMENTS AND DRAWINGS 5

1. SCOPE

1.1 This specification sets forth the minimum technical requirements for a lead storage battery (battery) to be provided to Minnesota Power (Purchaser) by the Supplier. The Supplier shall quote in strict conformance with these specifications. All exceptions to these specifications or any required standard shall be stated and explained in the submitted proposal.

1.2 Section 10.1 can be used to look up drawing numbers for references to Purchaser's drawings contained in this specification.

1.3 Delivery of the battery is required by [MM,DD,YYYY].

2. STANDARDS

The apparatus shall be designed, manufactured and tested in accordance with the latest revision of the following:

2.1 National Electric Safety Code (NESC) (IEEE C2)

2.2 National Electric Code (NEC) as amended and adopted by the state in which the EEE will be installed.

2.3 All other applicable or jurisdictional Codes and Standards (ex. ANSI, IEC, NEMA, ASTM, ICEA, IEEE, NFPA, UL, etc.)

3. GENERAL DESCRIPTION

3.1 The battery shall be rated:

3.1.1 Nominal control voltage see Table 1.

3.1.2 Number of cells see Table 1.

3.1.3 The battery shall be sized in accordance to IEEE Std 485-2010 utilizing the design parameters provided in the Table 1 and the load profile provided in Table 2.

3.1.4 Full charge specific gravity range 1.200 to 1.240.

3.2 Expected operating temperature range 10°C to 30°C.

3.3 Plates shall be of tubular construction.

4. ACCESSORIES

4.1 All necessary lead-plated inter-cell connectors, bolts, and hardware to allow 1/2" spacing between jars.

4.2 One portable hydrometer.

4.3 One set of necessary lifting devices.

4.4 One vent mounted thermometer.

4.5 One syringe holder for hydrometer.

4.6 One vent mounted hydrometer syringe.

4.7 One set of cell labels numbered 1 to 58.

4.8 One set of tools for inter-cell connections.

4.9 One set of flip top safety vent caps.

4.10 One battery rack for complete battery,

4.11 Battery rack shall be finished with two coats of acid resisting ANSI 61 gray paint. Rack zinc coated steel, with .06" of rail insulation.

4.12 Battery rack to be 2-Step/1-Tier construction arrangement.

4.12.1 Battery rack shall have provisions to be grounded with a NEMA 2 hole pad.

4.13 Rack shall provide for spill containment.

4.13.1 Spill containment shall be a polymer tray.

4.13.1.1 Stainless steel pans and acid resistant trays are unacceptable.

4.13.2 Spill containment shall include neutralizing pillows.

4.14 Terminal connectors, solderless.

4.15 Dead Front or Dead Top protection with direct testing access to posts and inter-cell connectors via probes.

4.16 2 oz. containers of no-oxide grease.

5. <u>INFORMATION REQUIRED SWITH PROPOSAL</u>

5.1 Supplier shall provide the following information with the proposal:

5.1.1 Manufacturers Catalog Number.

5.1.2 Number of cells per unit.

5.1.3 Guarantee period and expected life.

5.1.4 8-hour ampere hour capacity to 1.75 volts per cell at 25°C.

5.1.5 1-minute ampere rate to 1.75 volts per cell at 25°C.

5.1.5.1 Testing methods and results for 1-minute ampere rating.

5.1.6 Rack and cell dimensions and weight.

5.1.7 Short circuit available at output terminals (+, -).

5.1.8 Amount and type of gas generated during normal and equalize charging at a temperature of 70°F.

5.1.9 Discharge Characteristic Curve.

5.1.10 Annual Failure Rate of quoted cell type.

5.1.10.1 A cell failure is defined as any difficulty requiring return of a cell to a manufacturer.

5.1.10.2 Annual Failure Rate = $\frac{\text{Total Cell Failures since 1/1/2003}}{\text{Cell Service years since 1/1/2003}}$

5.1.11 All exceptions to these specifications or any standard in section 2.

6. RECORD DRAWINGS REQUIRED

6.1 Supplier shall provide one electronic and one paper copy of the following with the delivery of the battery:

6.1.1 Instruction Manual.

6.1.2 Rack outline drawing.

6.1.3 Battery unit outline drawing.

6.1.4 Manufacturer's battery specification sheet.

7. WARRANTY

7.1 Manufacturer shall provide a 20 year guarantee

8. SHIPMENT

8.1 The equipment shall be shipped FOB Destination, Prepaid & Allowed.

8.2 Vendor shall ship to:

LOCATION

8.3 The cells shall be shipped assembled and charged, ready for service, with the electrolyte in the cells.

8.4 Cells shall be properly packed and crated to protect them from damage in transit.

9. TABLES

9.1 Table 1: Individual Battery and Design Specifications

Project	Nominal Voltage	# Cells	Design Margin	Aging Factor	Temperature Correction Factor
Substation Name	130VDC	58	1.15	1.25	1.19 (10 °C)

9.2 Table 2: Load Profile

Period	Load (in Amps)	Time (in minutes)
1	Load	1
2	Load	478
3	Load	1

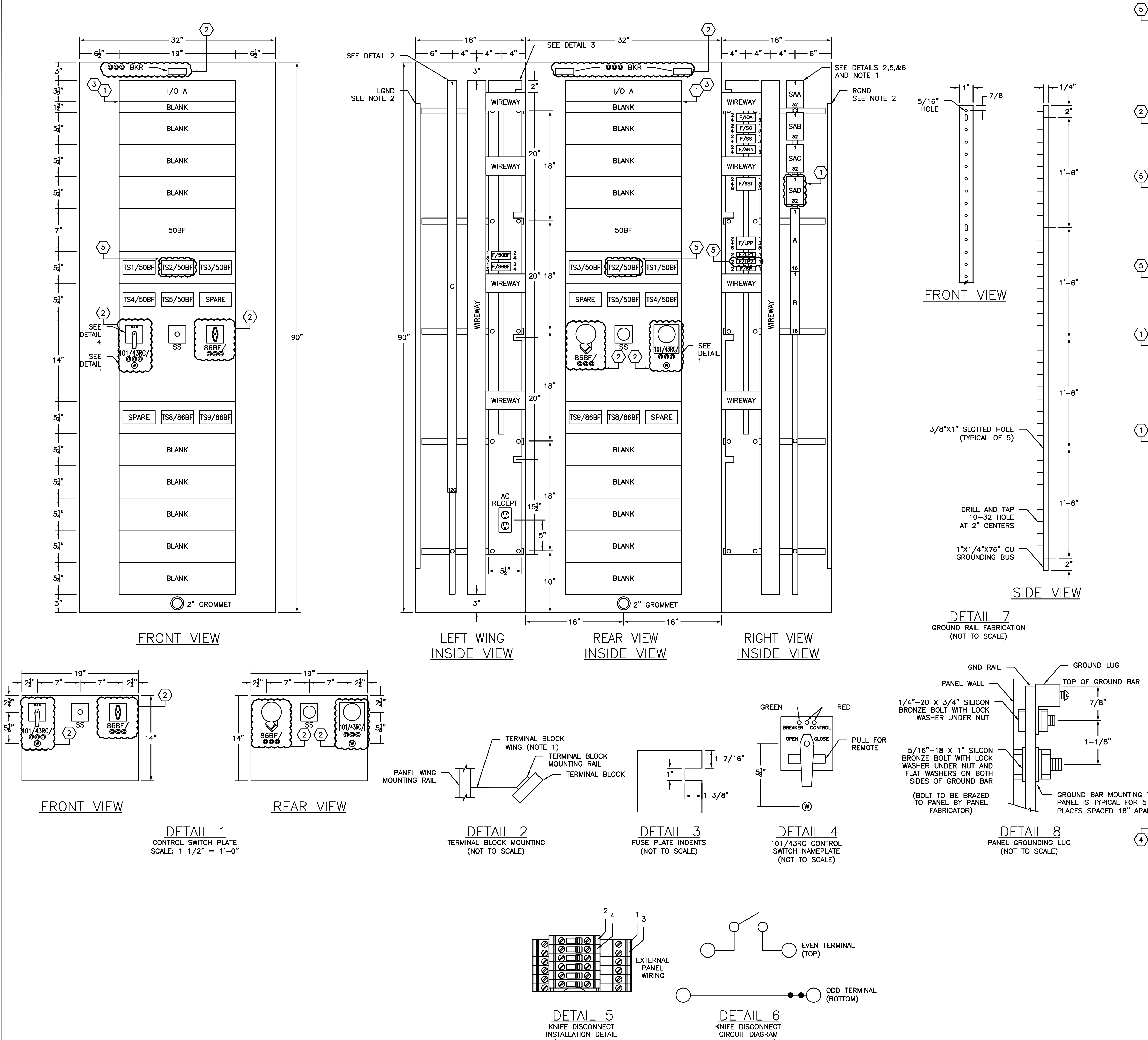
10. REVISION TABLE

Number	Date	By	Reviewed	Description
0	12/11/2019	BAH		Reformat of existing SB01PA Spec, Changed section numbering, Reset Revision to 0.

11. ATTACHMENTS AND DRAWINGS

11.1 The following drawings are referenced in the above specifications and include the battery that is to be provided by the Supplier.

Drawing #	Drawing Name
[ME-XXXXX-XX SHX]	[Drawing Title]
[ME-XXXXX-XX SHX]	[Drawing Title]
[ME-XXXXX-XX SHX]	[Drawing Title]
[ME-XXXXX-XX SHX]	[Drawing Title]



FRONT VIEW

LEFT WING INSIDE VIEW

REAR VIEW INSIDE VIEW

RIGHT VIEW INSIDE VIEW

DETAIL 7
GROUND RAIL FABRICATION
(NOT TO SCALE)

DETAIL 1
CONTROL SWITCH PLATE
SCALE: 1 1/2" = 1'-0"

DETAIL 2
TERMINAL BLOCK MOUNTING
(NOT TO SCALE)

DETAIL 3
FUSE PLATE INDENTS
(NOT TO SCALE)

DETAIL 4
101/43RC CONTROL SWITCH NAMEPLATE
(NOT TO SCALE)

DETAIL 8
PANEL GROUNDING LUG
(NOT TO SCALE)

DETAIL 5
KNIFE DISCONNECT INSTALLATION DETAIL
(NOT TO SCALE)

DETAIL 6
KNIFE DISCONNECT CIRCUIT DIAGRAM
(NOT TO SCALE)

MARK	QTY	DEVICE	MFGR.	TYPE	CATALOG NO.	RANGE	STORES	REMARKS
50BF	1	MICROPROCESSOR BREAKER FAILURE RELAY	SEL	451	04515615XB0X4H324XXXX			
I/O A	1	ORION I/O	NOVATECH		I/O-SX-2E-411X-AD-WR 42-44-98			
	2	TEST SWITCH BLANK PANEL	ABB	FT-19	FR3G000000000		6602412	
TS1/50BF, TS2/50BF	2 OR 1	TEST SWITCH - 6C - 4P RACK MOUNTED	ABB	FT-19R	R129A514G01		6602403	6C4P
TS3/50BF, TS4/50BF, TS5/50BF, TS8/86BF, TS9/86BF,	5	TEST SWITCH - 10P RACK MOUNTED	ABB	FT-19R	R129A501G01		6602404	10P
W	1	WHITE ILLUMINATING LIGHT	GE	ET-16 LED	116B6708G43W73W5	125V DC	6646003	
SS	1	SYNCH SWITCH W/ENGRAVING CODE 11D-2S17	ELECTRO	SERIES 24	2424E		6650755	
	1	SYNCH SWITCH OVAL REMOVABLE HANDLE	ELECTRO		002013-3			
101/43RC/@@@	1	BREAKER CONTROL SWITCH	ELECTRO	SERIES 24	88PDGRRX203FCLA		6650777	
86BF/@@@	1	BKR FAIL LOR W/ENGRAVING CODE 17C-2L22	ELECTRO	SERIES 24	7806D		6658201	
	1	BLUE HANDLE	ELECTRO	02000-11A-7				FOR 86BF
F/LP1, F/SP, F/LP2	2 OR 3	1-POLE FUSE HOLDER	MERSEN	ULTRASAFE	USCC1		3084985	
F/50BF, F/SC, F/SS, F/86BF, F/IOA, F/ANN	6	2-POLE FUSE HOLDER	MERSEN	ULTRASAFE	USCC2		3084990	
F/LPP, F/SST	2	3-POLE FUSE HOLDER	MERSEN	ULTRASAFE	USCC3		3084995	
(1)-F/LP1, (1)-F/LP2, (1)-F/SP, (2)-F/50BF, (2)-F/86BF, (3)-F/LPP	9 OR 10	10A FUSES	MERSEN	10A	ATMR10		3000110	
(2)-F/SC	2	6A FUSES	MERSEN	6A	ATMR6		3000106	
(3)-F/SST, (2)-F/SS, (2)-F/ANN	7	3A FUSES	MERSEN	3A	ATMR3		3000103	
2-F/IO	2	1A FUSE	MERSEN	1A	ATMR1		3000101	
SAA, SAB, SAC, SAD	48 OR 64	KNIFE DISCONNECT TERMINAL BLOCKS	PHOENIX	UTTB 4-MT	3044775		6676505	
	3 OR 4	S-BLOCK END COVER	PHOENIX	D-UTTB 2,5/4	3047293			
	4 OR 5	S-BLOCK END CLAMP	PHOENIX	CLIPFIX 35-5	3022276			
	1	MOUNTING RAIL	PHOENIX	NS35/7,5	801733		6676507	
	3 OR 4	TERMINAL BLOCK MARKER	PHOENIX	ZB 6, QR	1051029:0001			LABELED 1-10
	3 OR 4	TERMINAL BLOCK MARKER	PHOENIX	ZB 6, QR	1051029:0011			LABELED 11-20
	3 OR 4	TERMINAL BLOCK MARKER	PHOENIX	ZB 6, QR	1051029:0021			LABELED 21-30
	3 OR 4	TERMINAL BLOCK MARKER	PHOENIX	ZB 6, QR	1051029:0031			LABELED 31-40
	3 OR 4	TERMINAL STRIP MARKER CARRIER	PHOENIX	KLM 3	811969			
A, B, C	152	A-B-C TERMINAL BLOCKS	AB		1492-CD3	600V, 35A	6676500	
	3	A-B-C END BARRIER	AB		1492-N16		6676501	
	6	A-B-C END ANCHOR	AB		1492-N23		6676503	
	4	MOUNTING RAIL	AB		1492-N22		6676502	
	2	ALUMINUM MOUNTING CHANNEL	POWER STRUT		PS700J-10-AL			
LGND, RGND	2	1" X 1/4" X 76" COPPER GROUNDING RAIL					4596000	PER DETAIL 7
	2	GROUND LUG	BURNDY		KA28			
WIREWAY	4	3"X 3" WIREWAY	PANDUIT		F3X3LG6		6630803	GREY
	4	3" WIREWAY COVER	PANDUIT		C3LG6			
BLANK	1	14"x19" CONTROL SWITCH PLATE						
	8	5 1/4"x19" BLANK PLATE						
	1	1 3/4" X 19" BLANK PLATE						
AC RECEPT	1	120VAC, 20A DUPLEX RECEPTACLE	HUBBELL		HBL5362			
	1	HANDY BOX	APPLETON		180-1/2			
	1	RECEPTACLE COVER	APPLETON		180W			
2" GROMMET	1	2" SNAP BUSHING	HEYCO		2400			
LCOM 840	2	COAXIAL ADAPTERS BNC (M-F-F)	LCOM		BA840		9401741	
LCOM BC55	1	BNC FEMALE TO LEADS	LCOM		BC55			
TERM RESISTOR	1	BNC TERMINAL, 50-OHM TO RG-58 COAXIAL	AMPHENOL		RF 00-46650-51RFX			

NOTES:

1. VENDOR SHALL MOUNT TERMINAL BLOCKS AT 45° ANGLE FROM WING PER DETAIL 2.
2. GROUND ALL CT CABLES AND CABLE SHIELDS ON GROUND RAILS.

UNIQUE CHARACTER IDENTIFIERS

REPLACE IDENTIFIERS WITH EQUIPMENT DESIGNATION

@@@: ______ BKR CONTROLLED BY THIS PANEL

REMOVE ALL UNIQUE CHARACTER IDENTIFIERS NOTES.

KEYED DESIGN NOTES

1 INSTALL 1-SA BLOCK PER I/O CARD INSTALLED.
2 FILL IN BLANKS WITH INFORMATION FROM ENGINEERING M&R.
3 LEAVE AT LEAST 1RU BLANK BETWEEN I/O AND OTHER RACK EQUIPMENT FOR PANEL SIS WIRING.
4 FOR END OF IRIG CHAIN; OMIT IF IRIG CHAIN DOES NOT END AT THIS PANEL.
5 INCLUDE IF DUAL SYNC VOLTAGES ARE BEING USED. OMIT IF ONLY A SINGLE SYNC VOLTAGE IS USED.

REMOVE ALL KEYED DESIGN NOTES.
DELETE THE "Z-DESIGN (DELETE)" LAYER.

NO.	DATE	REVISION DESCRIPTION	BY	APPROVED	NO.	DATE	REVISION DESCRIPTION	BY	APPROVED
A	10-31-23	MP STANDARDS - FINAL ISSUE	BSN/BV	PJK/BV	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.

DRAWN BY	.
APPROVED	.
DATE	.
SCALE	1 1/2" = 1'-0"

AN ALLETE COMPANY

115/230kV STANDARD
@@@ BREAKER CONTROL PANEL
ELEVATION & BILL OF MATERIALS

SHEET 1 REV. A

ME-CTRSTD-14

CADD DRAWING - FOR REPRODUCTION ONLY

MICROFILMED / /

CODE . 3200 3508

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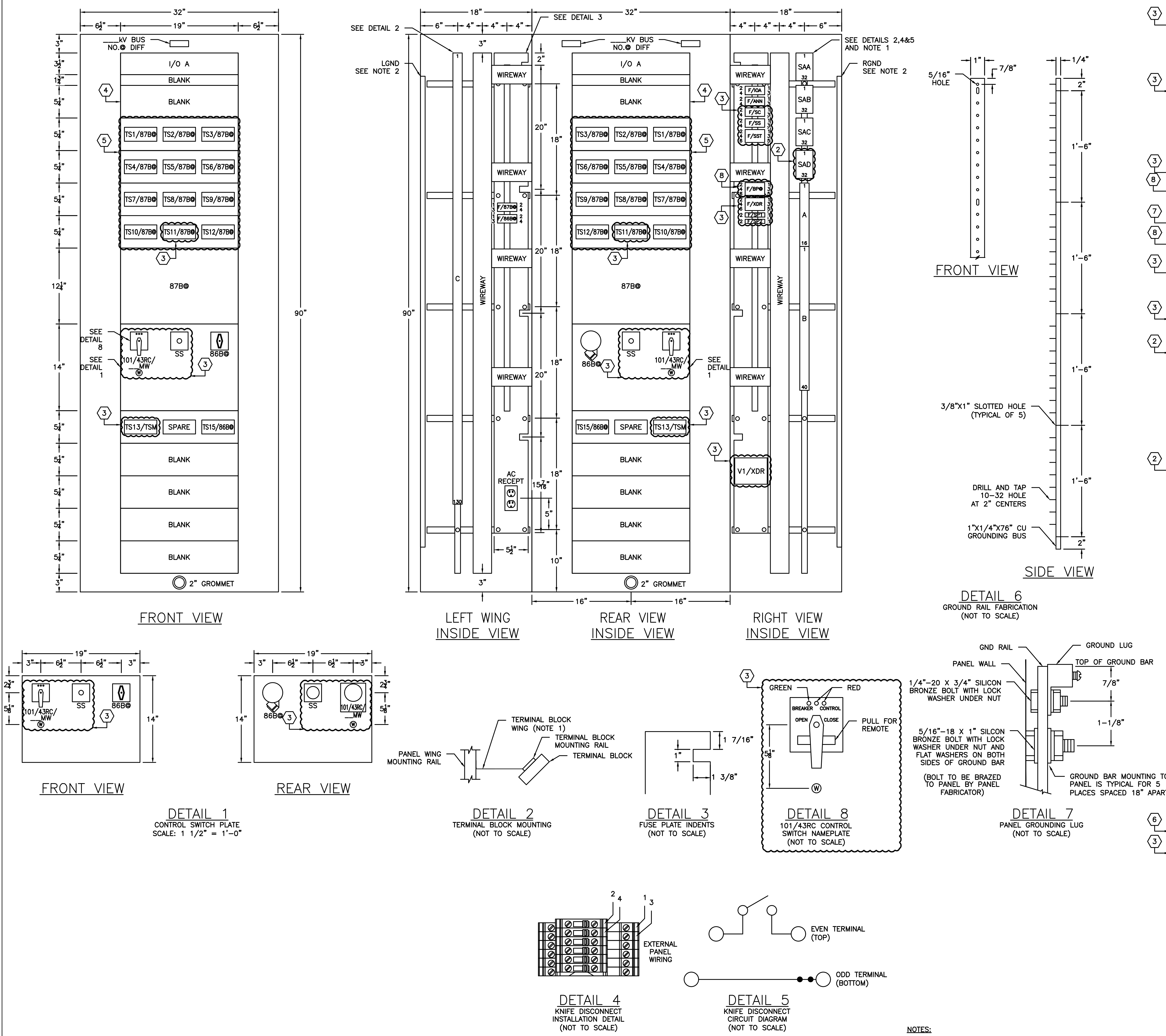

MARK	QTY	DEVICE	MFGR.	TYPE	CATALOG NO.	RANGE	STORES	REMARKS
87B@	1	BUS PROTECTION RELAY	SEL	487B	0487B1X6X52XB0XEH8PXXXX			
I/O A	1	ORION I/O	NOVATECH		I/O-SX-EP-411X-AD-WR 42-44-98			
	5	TEST SWITCH RACK ASSEMBLY	ABB	FT-19	FR3G000000000		6602412	
TS1/87B@, TS2/87B@, TS3/87B@, TS4/87B@, TS5/87B@, TS6/87B@, TS7/87B@, TS13/TSM	7 OR 8	TEST SWITCH – 6C – 4P RACK MOUNTED	ABB	FT-19	R129A514G01		6602403	6C4P
TS8/87B@, TS9/87B@, TS10/87B@, TS11/87B@, TS12/87B@, TS15/86B@	5 OR 6	TEST SWITCH – 10P RACK MOUNTED	ABB	FT-19	R129A501G01		6602404	10P
86B@	1	BUS DIFF LOR ENGRAVING CODE: 17C-2L22	ELECTRO	SERIES 24	7806D		6658201	
	1	W/ ORANGE HANDLE	ELECTRO	02000-11A-2				
SS	1	SYNCH SWITCH W/ENGRAVING CODE 11D-2S17	ELECTRO	SERIES 24	2424E		6650755	
	1	SYNCH SWITCH OVAL REMOVABLE HANDLE	ELECTRO		002013-3			
101/43RC/__MW	1	BREAKER CONTROL SWITCH	ELECTRO	SERIES 24	88PDGRRX203FCLA		6650777	
W	1	WHITE ILLUMINATING LIGHT	GE	ET-16 LED	116B6708G43W73W5	125V DC	6646003	
F/SP1, F/SP2	2	1-POLE FUSE HOLDER	MERSEN	ULTRASAFE	USCC1		3084985	
F/87B@, F/86B@, F/IO, F/ANN, F/SC, F/SS	4 OR 6	2-POLE FUSE HOLDER	MERSEN	ULTRASAFE	USCC2		3084990	
F/BP@, F/SST, F/XDR	1 OR 3	3-POLE FUSE HOLDER	MERSEN	ULTRASAFE	USCC3		3084995	
	8 OR 13	FUSE ANCHORS	PHOENIX	E/NS 35N	800886		6676506	
(3 OR 1)-F/BP@, (2)-F/86B@, (2)-F/87B@, (1)-F/SP1, (1)-F/SP2, (3)-F/XDR	7 OR 12	10A FUSES	MERSEN	10A	ATMR10		3000110	
(2)-F/SC	2	6A FUSES	MERSEN	6A	ATMR6		3000106	
(2)-F/ANN, (2)-F/SS, (2)-F/SC, (3)-F/SST	2 OR 7	3A FUSES	MERSEN	3A	ATMR3		3000103	
(2)-F/IO	2	1A FUSE	MERSEN	1A	ATMR1		3000101	
SAA, SAB, SAC, SAD	48 OR 64	KNIFE DISCONNECT S-TERMINAL BLOCKS	PHOENIX	UTTB-4-MT	3044775		6676505	
	3 OR 4	END COVER	PHOENIX	D-UTTB 2,5/4	3047293			
	4 OR 5	END CLAMP	PHOENIX	CLIPFIX 35-5	3022276			
	3 OR 4	TERMINAL STRIP MARKER CARRIER	PHOENIX	KLM 3	811969			
	1	MOUNTING RAIL – PHOENIX	PHOENIX	NS35/7,5	0801733		6676507	
	3 OR 4	TERMINAL BLOCK MARKER	PHOENIX	ZB 6, QR	1051029:0001			LABELED 1-10
	3 OR 4	TERMINAL BLOCK MARKER	PHOENIX	ZB 6, QR	1051029:0011			LABELED 11-20
	3 OR 4	TERMINAL BLOCK MARKER	PHOENIX	ZB 6, QR	1051029:0021			LABELED 21-30
	3 OR 4	TERMINAL BLOCK MARKER	PHOENIX	ZB 6, QR	1051029:0031			LABELED 31-40
A, B, C	186	A-B-C TERMINAL BLOCKS	AB		1492-CD3	600V, 35A	6676500	
	3	A-B-C BLOCK END BARRIER	AB		1492-N16		6676501	
	6	A-B-C BLOCK END ANCHOR	AB		1492-N23		6676503	
	4	MOUNTING RAIL – ALLEN BRADLEY	AB		1492-N22		6676502	
	2	ALUMINUM MOUNTING CHANNEL	POWER STRUT		PS700J-10-AL			
LGND, RGND	2	1" X 1/4" X 76" COPPER GROUNDING RAIL					4596000	
	2	GROUND LUG	BURNDY		KA28			
WIREWAY	4	3"X 3" WIREWAY	PANDUIT		F3X3LG6		6630803	
	4	3" WIREWAY COVER	PANDUIT		C3LG6			
	1	14"x19" CONTROL SWITCH PLATE						
BLANK	1	7"x19" BLANK PANEL						
BLANK	5	5 1/4"x19" BLANK PANEL						
BLANK	1	7"X19" BLANK PLATE						
2" GROMMET	1	SNAP BUSHING FITS 2" HOLE	HEYCO		2400			
AC RECEPT	1	120VAC 20A DUPLEX RECEPTACLE	HUBBELL		HBL5362			
	1	HANDY BOX	APPLETON		180-1/2			
	1	RECEPTACLE COVER	APPLETON		180W			
	2	COAXIAL ADAPTERS, BNC (M-F-F)	LCOM		BA840		9401741	
	1	BNC FEMALE TO 2-WIRE BREAKOUT	LCOM		BC55			
TERM RESISTOR	1	BNC TERMINAL, 50-OHM TO RG-58 COAXIAL	AMPHENOL		RF 00-46650-51RFX			
V1/XDR	1	VOLTAGE TRANSDUCER	SCIENTIFIC COLUMBUS		XLGV30S1-1	0-150V INPUT,0-1 mA OUTPUT	XXXXXX	

KEYED DESIGN NOTES

1. VERIFY RELAY CONFIGURATION AND PART NUMBERS WITH MP RELAY ENGINEERING PRIOR TO ISSUING PRINT.
2. INSTALL 1-SA BLOCK PER I/O CARD INSTALLED.
3. INCLUDE IF TIE BREAKER CONTROL IS BEING INSTALLED IN PANEL.
4. LEAVE AT LEAST 1RU BLANK BETWEEN I/O AND OTHER RACK EQUIPMENT FOR PANEL SIS WIRING.
5. ADJUST NUMBER OF TEST SWITCHES BASED ON BUS CONFIGURATION.
6. FOR END OF IRIG CHAIN; OMIT IF IRIG CHAIN DOES NOT END AT THIS PANEL.
7. ADJUST END CLAMPS BASED ON PANEL'S FUSE CONFIGURATIONS. INCLUDE ONE FUSE ABOVE AND BELOW EACH HOLDER.
8. CHANGE BP@ FUSE TO A 1-POLE FUSE HOLDER AND ONE 10A FUSE IF 115KV TIE BREAKER CONTROL IS INSTALLED IN THIS PANEL.

REMOVE ALL KEYED DESIGN NOTES.
DELETE THE "Z-DESIGN (DELETE)" LAYER.

UNIQUE CHARACTER IDENTIFIERS

REPLACE __MW WITH TIE BREAKER NAME IF BREAKER CONTROL IS INSTALLED IN THIS PANEL

REPLACE @ WITH BUS NUMBER:__

REMOVE ALL UNIQUE CHARACTER IDENTIFIERS NOTES.

NOTES:

1. TERMINAL BLOCKS SHALL BE MOUNTED ON WING ATTACHED TO PANEL WING MOUNTING RAIL AT 45° FROM WING. SEE DETAIL 2.
2. GROUND ALL CT'S AND CABLE SHIELDS ON GROUND RAIL.

NO.	DATE	REVISION DESCRIPTION	BY	APPROVED	NO.	DATE	REVISION DESCRIPTION	BY	APPROVED
A	10-31-23	MP STANDARDS – FINAL ISSUE	BSN/BV	PJK/BV	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.

DRAWN BY .
APPROVED .
DATE .
SCALE 1 1/2" = 1'-0"

AN ALLETE COMPANY

DISTRIBUTION LEVEL kV STANDARD
__kV BUS NO.@ DIFFERENTIAL PANEL
ELEVATION & BILL OF MATERIALS

SHEET 1 REV. A

ME-CTRSTD-15

CADD DRAWING – FOR REPRODUCTION ONLY

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/ /	.	4600	3508

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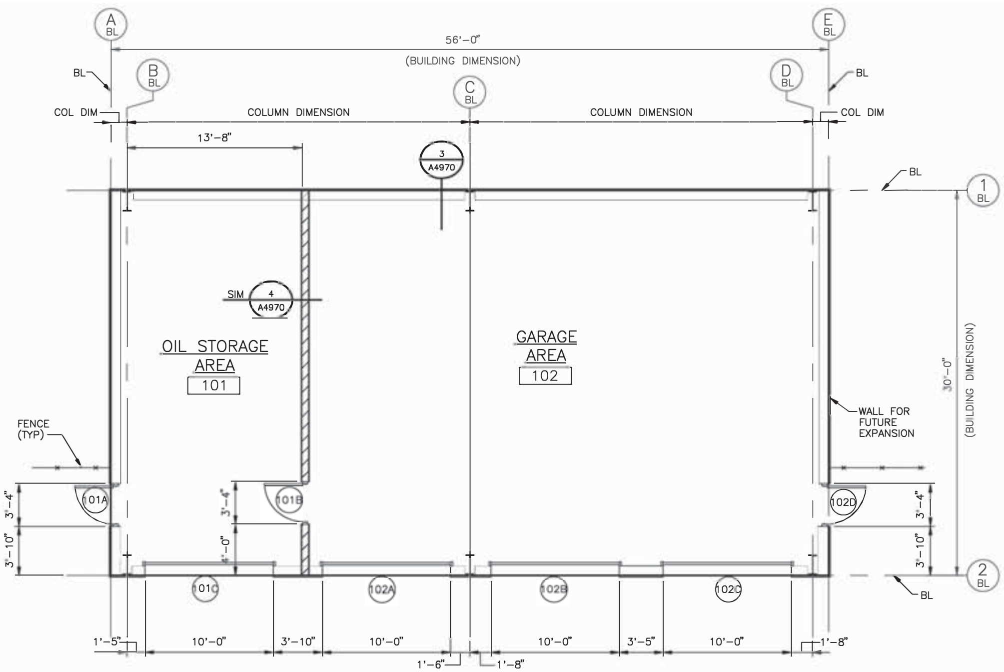
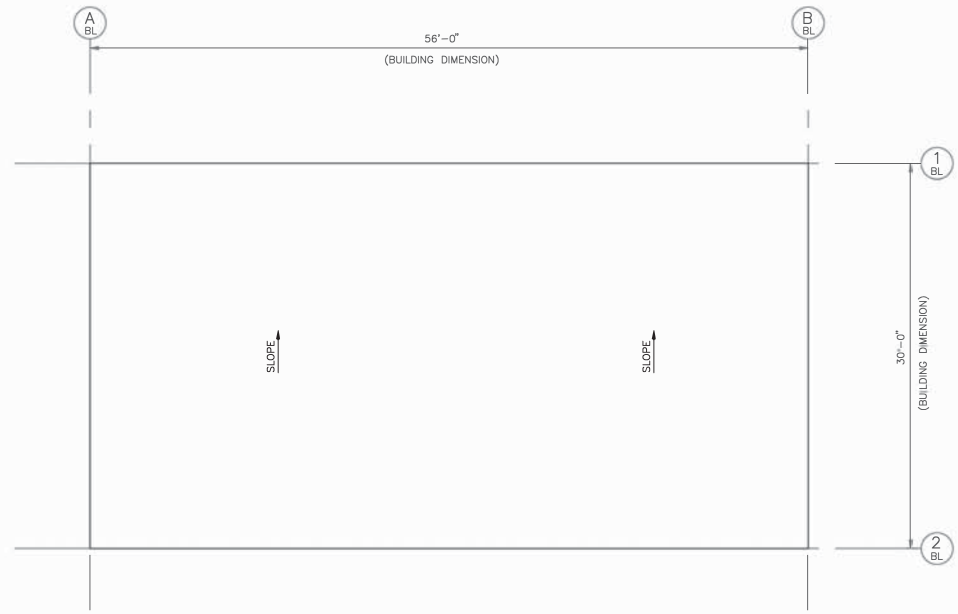
23.0 EXHIBIT 10 – OIL STORAGE, GARAGE SAMPLE FLOORPLAN



FLOOR PLAN
SCALE: 3/16"=1'-0"

NOTE: FLOOR PLAN SHOWS STRUCTURAL COLUMNS FOR INFORMATION PURPOSES, SIZE AND CONNECTIONS TO BE DETERMINED BY PRE-ENGINEERED METAL BUILDING FABRICATOR



ROOF PLAN
SCALE: 3/32"=1'-0"